ABSTRACTS OF NORTH AMERICAN GEOLOGY

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William T. Pecora, *Director*

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

The numbers assigned to the abstracts in this publication are for reference in using the index; they are not order numbers. Publications cited here in abstract form are available in most geological libraries or through interlibrary loan.

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A list of journals commonly cited in Abstracts of North American Geology may be obtained by writing to the U.S. Geological Survey, Washington, D. C. 20242. Serial publications cited for the first time are as follows:

Connecticut Univ. Inst. Water Resources Rept.—The University of Connecticut, Institute of Water Resources Report. Storrs, Conn.

Geol. Zhur.—Geologicheskiy Zhurnal. Akademiya Nauk Ukrain. SSR, Ministerstvo Geologii, Otdeleniye Nauk o Zemli i Kosmose. Izdatel'stvo "Naukova Dumka." Kiev, U.S.S.R.

Illinois Geog. Soc. Bull.—Bulletin of the Illinois Geographical Society. Northern Illinois University, Department of Geography. DeKalb, Ill.

Mineralog. Rec.—The Mineralogic Record. Mineralogic Record. Bowie, Md.

Research Council Alberta Map—Research Council of Alberta Map. Edmonton, Alberta.

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ABSTRACTS

Aadland, Rolf. *See* Picard, M. Dane. 02703

Abdel-Hady, Mohamed. *See* Matalucci, Rudolph V. 02306

02225 **Abelson, P. H.; Hare, P. E.** Uptake of amino acids by kerogen: Carnegie Inst. Washington Year Book 68, 1968-69, p. 297-303, tables, 1970.

02886 **Adams, J. I.** Effect of groundwater levels on stress history of the St. Clair clay till deposit — Discussion [of paper by L. G. Soderman and Y. D. Kim, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 190-193, illus., 1970.

Adams discusses the paper by Soderman and Kim (ibid., p. 173-187) and describes clays from a site south of Sarnia, southern Ontario. He concludes that large variations were found in a clay-till soil in both plan and profile within short distances. The plan variations are attributed to differences in vegetal cover resulting in differential drying and a variable crust thickness. — EH

02542 **Adams, James W., Jr.** *Glomar Challenger* continues its exciting mission: Ocean Industry, v. 5, no. 7, p. 34-37, illus., 1970.

On the second cruise of the *Glomar Challenger*, February 13 to June 1, 1970, two parts of the Deep Sea Drilling Project were completed. On Leg 10, 15 holes were drilled and cored in the Gulf of Mexico, the deepest to 2,900 feet. The oldest material recovered was 135 m.y. old; thick middle-Miocene turbidites were found. Natural gas, chiefly methane, was present in all holes, reaching maximum development at about 300 feet. On Leg 11 basalt was found under Jurassic limestones in the western North Atlantic Ocean. Shallow-water fossils in the limestones, deposited shortly after the ocean basin was formed as North America separated from Europe and Africa, indicate that the Atlantic was once shallow and that the separation occurred near the beginning of the Jurassic Period. At a site about 300 miles east of Cape Hatteras, a record depth of 3,320 feet was drilled below the ocean floor. — EH

02428 **Adams, Samuel S.** Geology in potash mining and exploration [abs.]: Mining Eng., v. 22, no. 1, p. 41, 1970.

Adams, William Mansfield. *See* Zetler, Bernard D. 02279

02575 **Adler, Lawrence.** Rock as a granulating material and mass: Soc. Mining Engineers AIME Trans., v. 247, no. 2, p. 180-186, illus., 1970.

In-situ rock has well-recognized rupture and yielding responses. Attention is called to an intermediate response, granulation, which consists of an evenly distributed, small-scale crumbling, accompanied by swelling. The presence of granulation can be demonstrated for a very wide scale, ranging from laboratory testing to regional geologic phenomena. The response of an engineered structure is considered in detail. Granulation appears to be dependent on internal moments, the formation of which can be controlled by engineering design. The practical implications of such control can be significant in optimizing underground instability and in improving excavation techniques. — *from* Author's abstract

02581 **Adshead, Patrica C.** Similarities between dental microstructures of scutellid echinoids and primitive vertebrates [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 833, 1970.

Ahmad, N. *See* Davis, C. E. 02838

Ahmed, S. *See* ElSwaify, S. A. 02383

Ahrens, Thomas J. *See* Gaffney, Edward S. 02817

02447 **Akili, W.** On the stress-creep relationship for a frozen clay soil: Materials Research and Standards, v. 10, no. 1, p. 16-22, illus., tables, 1970.

Creep tests were carried out on identically prepared and frozen clay samples at different stress-levels in the temperature range of -12° to -18°C. to ascertain the significance of a limiting creep stress that divides creep behavior of frozen soils into damped and undamped creep. The limiting stress was found to be equal to two thirds the ultimate strength of the tested samples. Data indicate that secondary creep rate (undamped creep) can be expressed in terms of temperature (T) and applied stress (σ) in the form of a relationship analogous to Eyring's reaction-rate equation. Data show also that creep rate of frozen clay soil depends on the stress-strain history of the samples and tends to decrease with increasing strain. — Author's abstract

Albers, John P. *See* Stewart, John H. 02400

02842 **Alexander, Robert H.** Mission 73 and associated tests, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 3-1 — 3-33, illus. [1970].

The Geographic Applications Program of the U.S. Geological Survey conducted a complex series of remote-sensing experiments (Mission 73) in southern California from April to June, 1968. The airborne multisensor mission included photographic, thermal infrared, passive microwave and radar sensors operating over a single site at a single time in the presence of ground-truth measurements. Observations were applied to four fields: land use, urban problems, surface energy balance and soil moisture. Techniques and equipment used are evaluated. Advantages of a complex mission over separate missions are: time constancy, time economy, rapid exchange of knowledge and techniques. — EH

Allen, J. H. *See* Martin, J. R. 02266

02807 **Allen, John Eliot.** Mount Rainier, our only glacial volcanic national park: Sci. and Children (Washington, D.C., Natl. Sci. Teachers Assoc.), v. 7, no. 6, p. 12-14, illus., 1970.

This popular account of Mt. Rainier National Park describes the varied volcanic history of the area, the destruction of Mt. Rainier, the last eruptions, recent glaciers, and other attractions. Seven references are given for further reading. — MCM

Allison, David E. *See* Edmondson, W. T. 02443

Allison, E. C. *See* Peterson, G. L. 02995

02774 **Am. Geological Institute.** (Committee on Manpower). Manpower supply and demand in earth science, 1969-1974: Washington, D.C., Am. Geol. Inst., 36 p., illus., 1970.

At the beginning of 1969, it is estimated that industry employed 70 percent of all professional earth scientists. Projected substantial increases in employment needs of mining and service industries over the next 5 years may be markedly offset by the petroleum industry's plans to hire 18 percent fewer earth scientists, particularly geologists. Government's need apparently will increase by 25 percent, and it is estimated 38 percent more faculty members will be needed by the end of 1974. Overall increase in total employment is expected to be no more than 4 percent. An apparent shortage of PhD degrees to fill earth-science positions is expected to continue through 1974, but the projected number of bachelor's and master's degrees exceeds the estimates of new employment. The demand for geophysicists is expected to be in excess of supply at all degree levels. — *from* Author's abstract

Amburgey, J. W., Jr. *See* Francis, C. W. 02553

Ames, H. Tate. *See* Ryder, Robert T. 02409

02420 **Andersland, O. B.; Douglas, A. G.** Soil deformation rates and activation energies [with French abs.]: Géotechnique, v. 20, no. 1, p. 1-16, illus., table, 1970.

Viscous flow of dilute soil-water mixtures and steady state creep of consolidated soils were studied to determine free energy of activation. Sault Ste. Marie clay, treated to remove carbonates, was divided into three batches and saturated with Li, Na, or K ions, and portions then dehydrated and saturated with nonpolar carbon tetrachloride. Viscosity of soil-water mixtures depended on concentration of solids and nature of adsorbed ions; highly hydrated Li ion caused more rapid increase in viscosity due to larger effective size. Free energy of activation of dilute soil suspensions was equal to pure water. Flow mechanism was that of free water; isolated clay particles made no contribution to free energy. Creep tests on consolidated clay gave a free energy of activation equal to about 28 kcal/mol. This value and flow volume of 1-7 cu A suggest ionic bonds at points of direct mineral to mineral contact. — *from* Authors' abstract

02954 **Anderson, B. J.; Jenne, E. A.** Free-iron and -manganese oxide content of reference clays: Soil Sci., v. 109, no. 3, p. 163-169, illus., table, 1970.

Appreciable amounts of free-iron oxides are associated with the reference clay minerals. Their presence may even prevent complete identification of the clay minerals present in soils and sediments. It is suggested that two phases represent surface oxide coatings on clay minerals and discrete oxide particles. Both the free-iron and -manganese oxides may be present in sufficient quantities to affect surface properties of the clay and to result in greater adsorption of cations. — JWH

02811 **Anderson, Don L.; Jordan, T.** The composition of the lower mantle, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 23-35, illus., tables, 1970.

The equation of state of the lower mantle is found by requiring that both the density and the seismic parameter $\Phi=(\alpha P/\alpha\rho)_s=V^2-(4/3)V_s^2$ be satisfied. The zero-pressure density and Φ of the lower mantle can then be found and the mean atomic weight can be inferred. For most published density models for the Earth the FeO content of the lower mantle is greater than the upper mantle. This indicates that the mantle is not homogeneous in composition as usually assumed. — Authors' abstract

02871 **Anderson, Don L.; Sammis, Charles.** Partial melting in the upper mantle, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 41-50, illus., tables, 1970.

The low velocity zone in tectonic and oceanic regions is too pronounced to be the effect of high temperature gradients alone. Partial melting is consistent with the low velocity, low Q and abrupt boundaries of this region of the upper mantle and also with measured heat flow values. Inferred low melting temperatures seem to indicate that water pressure is sufficiently high to lower the solidus about 200°C to 400°C below laboratory determinations of the melting point of anhydrous silicates. Mechanical instability of a partially molten layer in the upper mantle is probably an important source of tectonic energy. The top of the low-velocity zone can be considered a self-lubricated surface upon which the top of the mantle and the crust can slide with little friction. Lateral motion of crust and upper mantle away from oceanic rises is counterbalanced by flow of molten material in the low-velocity layer toward the rise where it emerges as new crust. If this lateral flow of molten material is not as efficient as upward removal of magma, regions of extrusion will migrate. — *from* Authors' abstract

02711 **Anderson, Edward K.** Surveys for materials and foundation studies: Surveying and Mapping, v. 30, no. 2, p. 257-262, illus., 1970.

This paper describes some basic surveying operations in the field of soil mechanics and foundation engineering. Surveying applications used for location of soils, minerals, and aggregate materials include interpretation of soil types and conditions on aerial photographs, development of subterranean contours of soil types from logs of test borings and topographic maps, and subterranean line and grade surveys associated with mining and tunneling. In surveying for foundation studies of the behavior of structures, measurements of differential movements of earth and structures include vertical movement of structures, movements of slopes, excavations and earth-retaining structures. — EH

02582 **Anderson, Edwin J.** Environment and synthesis of community models [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 833-834, 1970.

02814 **Anderson, Orson L.; Liebermann, Robert C.** Equations for the elastic constants and their pressure derivatives for three cubic lattices and some geophysical applications, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 61-85, illus., tables, 1970.

Lattice dynamic considerations and a Born repulsive potential between atoms lead to equations for elastic constants of the cubic NaCl, CsCl and ZnS lattices as a function of compression. Pressure derivatives of shear constants show strong dependence upon crystallographic structure. For isotropic shear modulus μ, $d\mu/dP$ is determined by Poisson's ratio and coordination of lattice ions. Low (possibly negative) values of $d\mu/dP$ are likely for several materials of importance to geophysics; such values would make low-velocity zones possible and interpretation of shock-wave data difficult. Vanishing of a shear constant predicts phase transitions at compression of 0.95 for ZnS lattice, 0.75 for NaCl lattice, and 0.60 for CsCl lattice. The CsCl transition is predicted even though none of the elastic constants have a negative pressure derivative at zero pressure. Equation of state parameters, K_s and $(dK/dP)_s$ (K is bulk modulus), are almost independent of crystallographic structure. K_s arises from the Laplacian of the repulsive potential — *from* Authors' abstract

02909 **Anderson, Richard R.** Remote sensing of marshlands and estuaries using color infrared photography, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 26-1 — 26-23, illus., table [1970].

There is a need for a rapid method of investigating estuaries and marshlands. Remote-sensing techniques, particularly color infrared photography, have shown promise as valuable tools in this type of research. This report involves experimentation with color infrared film and various Wratten filters (15-G, 25-A, 61, 89-B) in estuarine and marshland studies of the Patuxent River, Maryland. Conclusions are that color infrared film with use of various filters will provide information on various water-quality parameters and vegetation composition not obtainable using other remote-sensing methods. The Wratten 15-G filter appears to be most useful, but the Wratten 25-A filter may be superior in delineation of submerged aquatic plants. The Wratten 61 and 89-B filters provide a tool for specific plant type, distribution in marshes, and shoreline delineation. — Author's abstract

02499 **Anderson, Thomas B.** Cambrian and Ordovician stratigraphy of the southern Mosquito Range, Colorado: Mtn. Geologist, v. 7, no. 1, p. 51-64, illus., 1970.

Cambrian and Ordovician sedimentary rocks dip eastward into the South Park basin and crop out in a narrow band parallel to the north-south trending Mosquito Range in central Colorado. The oldest, Sawatch Quartzite of well-sorted unfossiliferous quartzite with alternating beds of dolomite, sandstone, sandy shale, and black shale of the Peerless Shale containing trilobite fragments, is well developed in northern sections, truncated southward by the pisolitic Manitou Limestone (Ordovician) which underlies the whole area. Cherty gray dolomite characterizes the Manitou which contains diagnostic cephalopods, trilobites, brachiopods, and cystoid plates. The Harding Sandstone of well-sorted quartzite, and the Fremont Limestone, medium-grained gray dolomite with abundant *Receptaculites*, occur in southern sections

only. Several periods of erosion have produced a series of disconformable, overlapping relations. — GDC

02540 **Antoine, John W.; Gilmore, James C.** Geology of the Gulf of Mexico: Ocean Industry, v. 5, no. 5, p. 34-38, illus., 1970.

Seven geologic provinces of the Gulf of Mexico are described with emphasis on the salt structures of the northern and western Gulf. If the folds off eastern Mexico are salt anticlines, the fold system depicts a natural model whose connection with the diapiric structures of the northern Gulf implies there has been a systematic development of salt structures in the northern and western Gulf of Mexico. Salt anticlines, formed under a relatively thin sedimentary cover, block transport of sediments from continental areas to the basin until each successive trough is buried and the entire anticline system is covered. As the sedimentary load increases above the folds, secondary growth features develop from the mother ridges. Continuing sediment influx increases the amount of vertical salt movement and further increases the complexity of the region. — EH

02583 **Antoine, John W.** Geology and hydrocarbon potential, deep Gulf of Mexico [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 834, 1970.

02832 **Applegate, Shelton P.** The vertebrate fauna of the Selma Formation of Alabama — Pt. 8, The fishes: Fieldiana — Geology Mem., v. 3, no. 8, p. [383]-433, illus., 1970.

The Mooreville Chalk, a formation in the lower part of the Upper Cretaceous Selma Group exposed in a belt across central Alabama, contains a rich fauna of fishes; at least 42 species, representing 28 genera and 17 families, are described here, including 6 new species and 3 new genera, *Propenser*, *Palelops*, *Moorevillia*. New higher taxa proposed are: the acipenserid subfamily Propenserinae; the elopoid superfamilies Pachyrhizodontoidea and Plethodoidea and, under the latter, the family Bananogmiidae; and the clupeoid superfamily Chirocentroidea. Paleoecology of the Mooreville is interpreted from the geological setting, sediments, fossil plants, invertebrates, and fishes; the Mooreville was probably deposited as an ooze in water over 600 feet deep, but fairly near the shore of the headland at the southern end of the Appalachian belt. — VMJ

Aratake, Nagaharu. *See* Uchida, Kinsuke. 02474

02423 **Archer, A. A.** Standardization of the size classification of naturally occurring particles: Géotechnique, v. 20, no. 1, p. 103-107, table, 1970.

British geologists and civil engineers favor a geometrically based scale to embrace the range between naturally occurring clay particles and boulders. In the United States, the scale most widely adopted by geologists is Wentworth's detailed scale (1922), but, except for one size, his divisions do not correspond with British sieves specified for mechanical analysis for civil engineers. Where class limits must include points of change in engineering properties, Glossop and Skempton (1945) consider a system of the Massachusetts Institute of Technology best suited, although it is not geometric. That of the American Society of Testing and Materials (1967) would be more convenient if sieve sizes fit class limits. Classification based on a simplified Wentworth scale is proposed. — GDC

02522 **Ashmun, Tod.** The mineralogy and some thoughts concerning the concentrating mechanisms for a mineral suite found as cavity fillings in limestone near Holmesville, Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 33, 1970.

02417 **Asquith, D. O.** Depositional topography and major marine environments, Late Cretaceous, Wyoming: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1184-1224, illus., table, 1970.

Detailed correlation of electric-log resistivity patterns that result from variations in bentonite content of marine shale and siltstone reveals the presence of inclined time-stratigraphic units within the Late Cretaceous section of Wyoming. The epicontinen-

tal marine section is divided into three major environments, shelf, slope, and basin; the inclined time-stratigraphic units were deposited on the slope, whereas thinner more flat-lying units were deposited on the shelf and in the basin. Examples from the Big Horn basin, Powder River basin, Red Desert and Washakie basins demonstrate the wide areal distribution and almost continuous presence of significant submarine topography during post-Turonian Late Cretaceous time. — WCC

02360 **Atakol, Kenan; Larew, H. Gordon.** Dynamic shearing resistance of dry Ottawa sand: Am. Soc. Civil Engineers Proc., v. 96, paper 7186, Jour. Soil Mechanics and Found. Div., no. SM2, p. 705-720, illus., table, 1970.

A relation between rate of deformation in simple shear, overburden pressure, shearing strength or stress on the failure plane at time of failure, and initial void ratio and changes in void ratio has been determined, using a modified apparatus with which simple shear or homogeneous deformation throughout the sample was obtained. Overburden pressures simulating soil depths to 100 feet were employed; dynamic shearing was accomplished in 0.004 sec, and static shearing in 120 sec. A projectile fired from a gun was used to initiate shearing in the dynamic case, and a metal lathe in the static case. A maximum rate of deformation, in terms of angular velocity, of 400 rad per sec was obtained. A mathematical equation describing a 3-dimensional surface which relates shearing strength, overburden pressure, and rate of deformation (angular velocity) was derived. — *from* ASCE abstract

Auh, Keunho. *See* Hummel, F. A. 02446

02436 **Awald, John T.** Regional geochemical reconnaissance of the Bradshaw Mountains, Arizona [abs.]: Mining Eng., v. 22, no. 1, p. 44, 1970.

Axley, J. H. *See* Woolson, E. A. 02866

02584 **Baars, D. L.; Bush, John; Nadeau, Joseph; Girdley, W. Arch.** Pre-Pennsylvanian paleotectonic framework of Ancestral Rockies of Colorado [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 834, 1970.

02585 **Bailey, N. J. L.; Krouse, H. Roy.** Chemical aspects of crude oil preservation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 834-835, 1970.

02796 **Baker, Richard G.** Pollen sequence from late Quaternary sediments in Yellowstone Park: Science, v. 168, no. 3938, p. 1449-1450, illus., 1970.

A radiocarbon-dated pollen diagram from a depression near the end of the southeast arm of Yellowstone Lake, Wyoming, records the vegetation sequence from the retreat of Late Wisconsin (Pinedale) ice to the present time. The tundra *Picea-Abies-Pinus albicaulis* (spruce-fir-whitebark pine) parkland vegetation inferred during late glacial time changed rapidly to a *Pinus contorta* (lodgepole pine) forest shortly before 11,550 carbon-14 years ago, suggesting a warming trend at that time. The *Pinus contorta* forest persisted with minor modification throughout postglacial time. — Author's abstract

02570 **Ballagh, T. M.; Runge, E. C. A.** Clay-rich horizons over limestone, illuvial or residual?: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 534-536, illus., table, 1970.

The formation of fine clay horizons over limestone in the soils studied is the result of illuviation. This conclusion is reached on the basis of C-14 dating, X-ray diffractograms, and clay size. — Soil brief

Balster, C. A. *See* Parsons, R. B. 02568

02586 **Bandy, Orville L.; Casey, Richard E.** Quaternary paleoclimatic variations [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 835, 1970.

Bankston, Donald C. *See* Thompson, Geoffrey. 02964

02469 **Barker, James C.** Willard L. Day (1899-1970): Houston Geol. Soc. Bull., v. 12, no. 10, p. 20, 1970.

Barlow, James A., Jr. *See* Haun, John D. 02627

Barnett, J. Dean. *See* Bassett, William A. 02813

02863 **Bar-On, P.; Shainberg, I.** Hydrolysis and decomposition of Na-montmorillonite in distilled water: Soil Sci., v. 109, no. 4, p. 241-246, illus., table, 1970.

Sodium montmorillonite was leached with distilled water. Upon leaching, 15 percent of the clay had dissolved, exchangeable sodium was replaced by Mg^{2+} and Al^{3+}, and the exchange capacity decreased. Preferential penetration of adsorbed hydrogen in the sites of isomorphous substitution was postulated to account for the high percent of Mg^{2+} in the adsorbed phase. — *from* Authors' summary

02920 **Barringer, A. R.** Regional reconnaissance techniques applied to exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 202-210, illus., 1970.

There is a major requirement for environmental geophysical and geochemical techniques which enable large areas to be scanned at low cost per unit area in order to select regions of major ore potential. Approaches to solving this problem are discussed and the use of a multiparameter airborne system is proposed for the detection of target areas based on geophysical and geochemical expressions of favourable geological conditions. A new airborne system called "Radiophase" is described which employs VLF radio fields transmitted by government stations. Brief mention is made of other new airborne geophysical and geochemical techniques under development. — Author's abstract

Bassett, W. A. *See* Mao, H. K. 02254

Bassett, W. A. *See* Mao, H. K. 02255

Bassett, William A. *See* Mao, H. K. 02812

02813 **Bassett, William A.; Barnett, J. Dean.** Isothermal compression of stishovite and coesite up to 85 kilobars at room temperature by X-ray diffraction, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 54-60, illus., tables, 1970.

X-ray diffraction (MoK_{alpha}) was used to obtain compression data on stishovite and coesite subjected to pressures up to 85 kb at 25°C in a tetrahedral press. Pressure was calculated from the lattice parameter of NaCl dispersed along with the sample in a plastic (Durez) which served as a pressure transmitting medium. Bulk moduli calculated from these data are 3.0 ± 0.3 Mb and 1.47 ± 0.15 Mb for stishovite and coesite, respectively. The compression along the *a* axis ($\Delta a/a_o$) is approximately twice the compression along the *c* axis ($\Delta c/c_o$) in stishovite with both axes decreasing monotonically. – Authors' abstract

Batten, James W. *See* Gibson, J. Sullivan. 02757

02465 **Baxter, James W.** Limestone and dolomite resources of Jersey County, Illinois: Illinois Geol. Survey Circ. 448, 28 p., illus., tables, geol. map, 1970.

Limestone and dolomite strata that include formations as old as the Dunleith Formation (Ordovician) and as young as the St. Louis Limestone (Mississippian) crop out in and adjacent to the bluffs of the Mississippi and Illinois Rivers in the western part of Jersey County. Outcrop study, insoluble residue data, and chemical analyses indicate that the Dunleith Formation, Joliet Formation, Burlington Limestone, and St. Louis Limestone are potential sources of quarry stone. The Burlington and Joliet are presently quarried in the county. Strata of Pennsylvanian age in eastern Jersey County contain thin limestone members of limited economic interest. Future quarries and

possibly underground mining of favorable beds will probably be located in or near the bluffs of the rivers where favorable formations occur at the surface or at shallow depths. — Author's abstract

02226 **Bell, P. M.; Mao, H. K.** Crystal-field spectra at high pressure: Carnegie Inst. Washington Year Book 68, 1968-69, p. 253-256, 1970.

02227 **Bell, P. M.; Chao, E. T. C.** Annealing experiments with naturally and experimentally shocked feldspar glasses: Carnegie Inst. Washington Year Book 68, 1968-69, p. 336-339, illus., table, 1970.

02228 **Bell, P. M.; Kullerud, G.** Acanthite-type compounds: Carnegie Inst. Washington Year Book 68, 1968-69, p. 276-277, illus., 1970.

02229 **Bell, P. M.; El Goresy, A.; England, J. L.; Kullerud, G.** Pressure-temperature diagram for Cr_3FeS_4: Carnegie Inst. Washington Year Book 68, 1968-69, p. 277-278, illus., 1970.

02986 **Benham, Milford J.** The nature of the deeper crust of central Arizona suggested by geophysical data [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 66, 1970.

02513 **Bennett, G.; McNally, N. K.** Strathcona Township, District of Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 596, scale 1 in. to 1/4 mi., text, 1970.

Oldest rocks, mafic pillowed metavolcanics which underlie the southeastern part of Strathcona Township, are overlain by a complex assemblage of felsic to intermediate flows, dikes, and pyroclastics in two sections; these are overlain by metavolcanics, pyroclastics, metasediments, and iron formation which crop out principally in the northwestern section. Olivine diabase dikes cut all major rock types. A syncline is evident in one section, and numerous faults are present. Iron is mined in the northwestern part, and small amounts of base metals, gold, silver, and rare earths have been found. — MCM

02733 **Bennett, G.; McNally, N. K.** Briggs Township, District of Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 595, scale 1 in. to 1/4 mi., text, 1970.

Oldest rocks in Briggs Township are the porphyritic mafic flows which lie along the southern boundary southeast of Amphibolite Bay. Persistent dikes of post-Nipissing olivine diabase age are the youngest rocks. The axis of a major syncline trends through Tetapaga Lake; northeast-trending shear zones suggest the presence of a major fault or fault zone under the waters of Lake Timagami. An iron formation generally less than 40 feet thick is too low grade to be of present economic interest; possibilities exist for base metals and gold. — MCM

02883 **Bérard, J.** Black shale heaving at Ottawa, Canada – Discussion [of paper by R. M. Quigley and R. W. Vogan, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 113-114, 1970.

Berard, discussing the article by Quigley and Vogan (ibid., p. 106-112) on heaving of drained black shales as an end result of bacterial action, states that oxidation of pyrite can take place even without bacterial action. — EH

Berberian, Paul. *See* Estes, Richard. 02754

02471 **Berg, R. B.** (compiler). Current geological and geophysical studies in Montana: Montana Bur. Mines and Geology Spec. Pub. 50, 24 p., 1970.

This list of studies includes projects of the U.S. Geological Survey and the Montana Bureau of Mines and Geology, and studies by university faculty members and graduate students. The 168 studies are divided into the following categories: areal geology; structural geology; stratigraphy, sedimentary petrology, and paleontology; geochemistry, mineralogy, and petrology; isotope geology and geochronology;

geophysics; geomorphology and glacial geology; hydrogeology; mineral fuels; economic geology; and environmental geology. — MCM

02587 **Berg, Robert R.; Davies, David K.** Depositional environments of Muddy reservoir sandstones (Lower Cretaceous) in Powder River basin, Montana and Wyoming [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 835, 1970.

Berg, Robert R. *See* Geol. Soc. America So.-Central Sec. 02798

02800 **Berg, Robert R.** Stratigraphy of the Claiborne Group, *in* Outcrops of the Claiborne Group in the Brazos Valley, southeast Texas — Geol. Soc. America South-Central Sec., 4th Ann. Mtg., 1970, Guidebook: [College Station, Tex.] Texas A and M Univ., Dept. Geology, p. 12-16, illus., 1970.

Sedimentary rocks of the Claiborne Group represent interfingering marine and nonmarine sediments of Middle Eocene Age. The Claiborne Group succeeds the dominantly nonmarine section of the Wilcox Gropu and is in turn succeeded by marine sediments of the Jackson Group. The Claiborne section is about 2,600 feet thick in the Brazos Valley; the lower half is marine shale with interbedded marine to fluvial sandstones, and the upper half is dominantly nonmarine sandstone and shale. The Claiborne rocks represent a major cycle of deposition that begins with a marine transgression and is characterized by repeated regressions and transgressions. Claiborne deposition ended with a major regressive cycle. The various formations of the Group are described. — EH

02588 **Bergendahl, Maximilian M.** Expanded need for mineral economics in exploration for metals [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 835, 1970.

02997 **Berkes, John S.; Roy, Rustum.** Use of ion properties for the prediction of the phase relations in a binary system [with German abs.]: Zeitschr. Kristallographie, v. 131, nos. 1-2, p. 60-72, illus., tables, 1970.

Characteristics of binary oxide systems have been correlated with electrostatic field-strength differences ΔFS of end-member cations for 160 binary oxide systems. Analysis of data indicates trends and establishes necessity in use of magnitude of ΔFS to predict occurrence of a particular characteristic of a system. Number of congruently and incongruently melting compounds increases as a function of ΔFS; extent of solid solution is maximum when $\Delta FS = 0$ and decreases rapidly as it increases, and reaches zero when $\Delta FS > 0.4$. For most systems, liquid immiscibility was only noted if $0.5 < \Delta FS < 1.0$, but a few exhibited liquid immiscibility below 0.5. By separating data into groups of systems in which end members had the same valence, a marked improvement could be seen in correlation of number of congruently and incongruently melting compounds with <FS. — *from* Authors' abstract

02760 **Bertin, Eugene P.** Principles and practice of X-ray spectrometric analysis: New York and London, Plenum Press, 679 p., illus., tables, 1970.

02914 **Bhattacharyya, B. K.** Semiautomatic methods of interpretation of magnetic data [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 32-45, illus., 1970.

Sources of error inherent in digitizing published aeromagnetic maps at uniform intervals could be eliminated by recording magnetic field values digitally only along flight lines; irregularly distributed data can be treated for interpolation at grid points located at intersections of a rectangular grid system. Available techniques for quantitative treatment of data normally determine some or all of: continuation fields, second vertical derivatives, fields reduced to the pole, and filtered anomaly fields. These transformations of the total-field anomaly are carried out for depicting unknowns regarding the causative body in a diagnostic way. In the final stage of interpretation individual anomalies in the residual map are analyzed by different methods for geometry of causative bodies. Examples of application of various techniques to actual magnetic data cover both mineral exploration work and geological mapping. — *from* Author's abstract

02748 **Bideaux, Richard A.** A multiple Japan law quartz twin: Mineralog. Rec., v. 1, no. 1, p. 33, illus., 1970.

Contact twins of quartz with composition plane (1122), opposed sets of coplanar prism faces, and c-axes inclined at 84° 33′ are known as Japan law twins. Accompanying photographs illustrate a group of three quartz crystals related by this law. The specimen was collected on a mine dump near the Yankee Boy mine in Gila County, Ariz. — ESL

03003 **Bidgood, D. E. T.; Blanchard, J. E.** Geophysical investigations of evaporites in Nova Scotia [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 497-503, illus., table, 1970.

Major evaporite deposits in Nova Scotia occur in a marine sequence in the Upper Mississippian. Salt, anhydrite, gypsum, dolomite, limestone, and potash are present in that approximate order of abundance; all except potash are presently exploited. A number of major structures which cause large negative gravity anomalies primarily due to rock salt have curious associated magnetic anomalies. Seismic reflection surveys have been partially successful in delineating the shapes, gamma-ray logging of exploratory boreholes has supplemented continuous coring in finding potash, gravity and electrical exploration have outlined shallow anhydrite and gypsum occurrences, and seismic refraction has been used to outline a limestone deposit. In areas with complicated geology and thick glacial till, geophysical techniques can provide important additional information required for successful exploration of industrial minerals. — *from* Authors' abstract

02836 **Bienlewski, Carl L.** Demand and supply of molybdenum in the United States: U.S. Bur. Mines Inf. Circ. 8446, 61 p., illus., tables, 1970.

Data on U.S. and Free World demand and supply of molybdenum through 1966 are presented, and related topics including previous predictions and methods of projections, extraction processes, trends in pricing, world trade, costs of mining and processing are discussed. U.S. production amounted to 90.5 million pounds of molybdenum in 1966, a five-fold increase over 1945. In 1966 two-thirds of the domestic consumption went into steel as an alloying element. U.S. reserves of recoverable molybdenum are estimated to be 5.9 billion pounds. Predictions are made indicating that in 1975 total Free World production will amount to 246 million pounds of molybdenum, with 98.5 percent coming from the U.S., Canada, Chile, and Peru. — RUK

02296 **Bihl, Gerhard.** New evidence on the age of the Sheerness badlands, east-central Alberta: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 216-237, illus., 1970.

Diagnostic fossil angiosperm pollen figured from an outcrop section show that lower Edmonton (pre-Lance) sediments are exposed near Sheerness, Alberta (Sec. 22, Twp. 29, Rge. 13, W. 4th Mer.). These strata are of the same age as the beds below the Drumheller Marine Tongue of the Edmonton Formation exposed in the type section at Drumheller, Alberta (Sec. 14, Twp. 29, Rge. 20, W. 4th Mer.). Structural data obtained from oil-well records between the two localities substantiate the fossil evidence, which shows that no sediments of Lance age are present in the Sheerness badlands. — Author's abstract

Billings, Gale K. *See* Hitchon, Brian. 02630

02555 **Bilyavs'kiy, G. O.; Mitropol's'kiy, O. Yu.; Romanov, V. I.** Pro kharakter rozpodilu luzhnikh zemel' i lugiv y donnikh osadkakh Pivnichno-Zakhidnoy Atlantiki [The distribution of alkali earth and alkali metals in bottom sediments of the northwestern Atlantic Ocean]: Geol. Zhur., v. 30, no. 2, p. 135-141, illus., 1970.

The distribution, composition, and physical, chemical, and mechanical properties of alkali earths and metals from sediments of the northwestern Atlantic Ocean are discussed. Cores were sampled from sections through the Atlantic Current from the Azore Islands to the eastern slope of the Flemish Cape Bank; in Newfoundland Bank and along the Gulf Steam and Labrador Current and at their intersection; and in

Davis Strait from the Canadian coast in Hamilton Bay, northeastward to the Mid-Oceanic Canyon near the Labrador Current. All analyzed elements were separated into two genetic groups: (1) Ca, Sr, Ba, Mg, and K, and (2) Be and Na. Elements of the first group are distributed more or less uniformly in the areas studied with smooth variation of concentrations in vertical direction. Distribution of the second group of elements coincides with that of clastic materials transported by the Labrador current and Gulf Stream from continental land masses. — EH

02815 **Birch, Francis.** Interpretations of the low-velocity zone, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc: Physics Earth and Planetary Interiors, v. 3, p. 178-181, illus., table, 1970.

The physical interpretation of the low-velocity zone of the upper mantle depends critically upon details of the velocity variation which are still uncertain. As examples, Gutenberg's solution is roughly consistent with a homogeneous layer of peridotite affected only by temperature and pressure, while Anderson's is not. Partial melting, relaxation of elasticity and compositional changes are among the suggested explanations. New evidence derived from the free oscillations by Press indicates that the low-velocity layer may also be a high-density layer; this might be eclogite or iron-rich peridotite. — Author's abstract

02336 **Bishop, B. A.** Stratigraphy of Sierra de Picachos and vicinity, Nuevo León, Mexico: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1245-1270, illus., 1970.

The Sierra de Picachos section is about 4,900 feet thick and is divisible into seven formations, from oldest to youngest: Cupido, La Peña, Tamaulipas, Sombreretillo (new), Cuesta del Cura, San Felipe (redefined), and Méndez. The section is mainly lithified carbonate mud (micrite) limestone with lesser amounts of dolomite, chert, and terrigenous clay. The micrite is classified into types based on organic constituents, principally foraminifers, calcispheres, tintinnids, and radiolarians, and, except for the Cupido Limestone, represents basinal deposits. Chert formed during diagenesis and is thought to have come from siliceous organisms. Deposition of carbonate mud was interrupted several times by influx of terrigenous clay resulting from climatic changes and/or tectonism, the final flood being produced by the Laramide orogeny and terminating carbonate deposition. — *from* Author's abstract

Black, Craig C. *See* Dawson, Mary R. 03011

02743 **Blackstone, D. L., Jr.** Structural geology of the Rex Lake quadrangle, Laramie basin, Wyoming: Wyoming Geol. Survey Prelim. Rept. 11, 17 p., illus., tables, geol. map, 1970.

The quadrangle area, approximately 25 mi west of Laramie, Wyo., lies in Albany County on the east flank of the Medicine Bow Mts., and includes part of Centennial Valley and Sheep Mtn. Stratigraphic units, from Precambrian to Quaternary are listed in a table, as are problems of correlation. Structural features include a limited exposure of the southern part of the Arlington fault system that partially bounds the east flank of the northern Medicine Bow Mts., the Centennial Valley-Mill Creek syncline, the Rex Lake anticline, the northern end of the Sheep Mtn. block with associated faults and folds, a possible recumbent fold under the Arlington thrust, and normal faults. The development of the geologic structure and the age of faulting are discussed. — EH

Blair, Robert W., Jr. *See* Donnell, John R. 02424

Blanchard, J. E. *See* Bidgood, D. E. T. 03003

02974 **Blazey, Edward B.** Fossil flora of the Mogollon Rim of Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 23, 1970.

02851 **Blinn, John C., 3d; Chapman, Peter; Quade, Jack.** Airborne multifrequency microwave radiometric sensing of an exposed volcanic province, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography,

and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 18-1 — 18-39, App. p. 18A1-18A8, p. 18B1-18B8, p. 18C1, illus., tables, reprinted [1970]; originally published, 1968.

An empirical study was conducted, using airborne and ground-based sensors, to search for correlations between multispectral microwave brightness temperatures and geologic parameters. The test site near Mount Lassen, California, was chosen for its simple topography, large distinct areas of homogeneous composition, roughness characteristics, and lack of vegetation. Radiometers were flown over preselected flight lines. Results of ground-truth studies and analysis of aircraft overflights show a distinction between cinder and lava. Results from an area of cinder layered over lava show a distinctive response, which may be related to cinder thickness. Further experimentation is recommended. — *from* Author's abstract

02501 **Blood, W. A.** Upper portion of the Fountain Formation and Lyons Formation at Morrison, Colorado: Mtn. Geologist, v. 7, no. 1, p. 33-48, illus., 1970.

Study of a detailed section of 325 feet of strata has locally established the boundary between these Pennsylvanian-Permian formations, tentatively subdivided the Lyons into three units, and established NNW-SSE current directions during Lyons deposition. The Fountain's upper crossbedded conglomeratic part, 180 feet thick, represents transition from red beds and flood-plain deposits to the more homogeneous Lyons sandstone, 144.6 feet thick. In the Lyons, Unit A, crossbedded like the Fountain but lithologically more mature, is 14 feet thick; Unit B, quartz sandstone 71.5 feet thick, has planar, tangential, wedge-type cross-stratification; and Unit C, 59.1 feet thick, lithologically similar to Unit B, lacks significant crossbedding. The Lyons is interpreted as a beach and near-shore deposit; the Fountain-Lyons-Lykins sequence represents a change from continental to shallow marine or beach conditions. — GDC

02589 **Bloom, Arthur L.** Geomorphology of reef complexes [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 836, 1970.

Bloom, D. N. *See* DeVoto, R. H. 02556

02435 **Bloom, Harold; Hawkes, Herbert E.** The continuing education of the exploration geochemist, a report of an experimental workshop [abs.]: Mining Eng., v. 22, no. 1, p. 44, 1970.

02480 **Bluemle, John P.; Kume, Jack.** Guide to the geology of Burleigh County, North Dakota: North Dakota Geol. Survey Misc. Ser., no. 42, 35 p., illus., geol. map, 1970.

This guidebook, based on Bulletin 42 of the North Dakota Geological Survey, is designed to illustrate a few general geologic concepts using examples from the geology of Burleigh County. Chapters cover the general geologic history of the county, the sedimentary rocks, glacial history and features, and economic geology, of sand, gravel and lignite deposits and ground-water resources. Four road logs include stops at scenic and geologic features in the county. — EH

02270 **Bogard, D. D.; Clark, R.; Hart, W.; Keith, J.; Reynolds, M.** Noble gas determinations and gamma ray spectroscopy of the Lost City chondrite [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

02546 **Bohn, H. L.** Comparisons of measured and theoretical Mn^{2+} concentrations in soil suspensions: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 195-197, illus., tables, 1970.

The Mn^{2+} concentrations in control and autoclaved suspensions of nine acid and alkaline soils [from southeastern United States and Michigan] in 0.01*M* $CaCl_2$ differed widely from the Mn^{2+} concentrations calculated from models which either require measurement of Eh or assume Eh to be fixed by another redox couple. An alternative model is proposed which expresses the equilibrium solubility of the manganese compounds in terms of pH-1/2pMn. The values of pH-1/2pMn measured in the suspensions of all the soils tested correspond to the solubility of MnO_2. — Author's abstract

02305 **Bollinger, G. A.; Hopper, Margaret G.** The Elgood, West Virginia earthquake of November 20, 1969: Earthquake Notes, v. 41, no. 1, p. 19-30, illus., tables, 1970.

The Elgood, West Virginia, earthquake occurred at 01:00:10.3 GMT on November 20, 1969. Its epicenter was determined as 37.4°N., 81.0°W., just west of the town of Elgood, West Virginia, and some 12 kilometers north of the Virginia-West Virginia border. The focus of this shock was shallow, probably 10 km or less. Six regional stations indicated a m_{LH} of 4.6 and five teleseismic stations gave a m_b of 4.3. A three-day microearthquake survey in the epicentral region recorded five definite and four possible seismic events with S-P times of less than five seconds. Macroseismic data were gathered by field surveys and by questionnaires. These data indicated a maximum MM Intensity of V and a felt region of 125,000 square miles over nine Mid-Atlantic states. — Authors' abstract

02492 **Bolton, R. J.** Computers interpret aeromagnetic maps: Oilweek, v. 20, no. 50, p. 42, 45-46, illus., 1970.

Techniques for calculating various derivative values from aeromagnetic information have not had wide usage because of lack of digital aeromagnetic data and proven production-type inexpensive processing routines. In the last year most of these deficiencies have been overcome by: digital recording devices installed in aircraft for recovering aeromagnetic data; techniques and hardware available for digitizing old, hand-produced aeromagnetic maps to sufficient detail for users to apply the derivative techniques; drop in cost of computer time; and general availability of production computer programs, so that the user does not have to pay the tremendous costs of programming. Illustrations are given, with some description of processes, reasons for using the computer, and examples of maps derived. — GDC

02579 **Bond, T. A.** Radiocarbon dates of peat from Okefenokee Swamp, Georgia: Southeastern Geology, v. 11, no. 3, p. 199-201, tables, 1970.

Peat samples collected from the eastern margin of Okefenokee Swamp, Georgia, yielded radiocarbon dates of 5140 ± 417 and 5260 ± 360 years B. P. The dates are the first reported for this area of the swamp and are interpreted as marking the beginning of deposition of organic matter in the eastern portion of the swamp. — Author's abstract

Bonilla, Manuel G. *See* McCulloch, David S. 02316

Bonner, W. P. *See* Francis, C. W. 02553

02590 **Boothroyd, Jon C.** Recent braided-stream sedimentation, south-central, Alaska [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 836, 1970.

Boothroyd, Jon C. *See* Hayes, Miles O. 02628

02753 **Boss, Kenneth Jay.** *Fimbria* and its lucinoid affinities (Mollusca; Bivalvia): Breviora, no. 350, 16 p., illus., table, 1970.

Fimbria is the only surviving genus of the Fibriidae, a family of bivalve mollusks that flourished during the Mesozoic. The conchological and anatomical features of *Fimbria* [*fimbriata*] show that the family belongs to the superfamily Lucinacea and that it is closely allied to the Lucinidae. The systematic position of the Fimbriidae in relation to other lucinoid families is discussed, and a possible phylogeny for the superfamily is reconstructed. — Author's abstract

02916 **Bosschart, Robbert A.** Ground electromagnetic methods [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 67-80, illus., 1970.

The basic methods of ground electromagnetic prospecting have undergone little change during the last three decades and only a few truly novel procedures have been added during this period. Major advances have, however, been made in instrumentation as well as in the interpretation of field data. As a result the effectiveness of elec-

tromagnetic prospecting has markedly improved over the years. The most widely used contemporary methods are briefly described. The effect on the response of frequency, coil configuration and other relevant characteristics determining the range of applicability of the respective systems is discussed and the effectiveness in different geological environments is compared. — Author's abstract

02765 **Boswell, E. H.; Thomson, F. H.; Shattles, D. E.** Water for industrial development in Clarke, Jasper, Lauderdale, Newton, Scott, and Smith Counties: Jackson, Miss., Mississippi Research and Devel. Center, 62 p., illus., tables, 1970.

Large quantities of water are available for industrial purposes in these east-central Mississippi counties; about 21 mgd is presently withdrawn. Largest sources of water are the Miocene Catahoula and the Eocene Sparta and lower Wilcox aquifers. The nine extensive aquifers underlying the area are capable of sustaining many times the present withdrawal. Water levels have not declined at a rapid rate except in a few places. The fresh-water section averages more than 1,500 feet thick and attains a maximum thickness of about 3,500 feet in Smith County. In 85 percent of the area, at least one aquifer contains water suitable for general use with little or no treatment; color, corrosiveness, and iron are problems in some places. — *from* Authors' abstract

Bouma, Arnold H. *See* Chmelik, Frank B. 02541

02843 **Bowden, Leonard W.** Southern California regional resources studies, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 4-1 — 4-29, illus., table [1970].

The Southern California Test Site 30 was established for detailed testing of sensor capabilities versus geographic characteristics and data needs. Data for this study were provided by various types of sensors and aerial photography. Objectives of the tests included land use, urban problems, surface energy balance, soil moisture, vegetation mapping, and air pollution analysis. Summary evaluations of the performance of each sensor used are given and future needs and objectives are outlined. — EH

02921 **Boyd, David.** The contribution of airborne magnetic surveys to geological mapping [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 213-227, illus., 1970.

Airborne magnetic surveying, a most useful tool for aid in geologic mapping, provides information at a reasonable proportion of cost of ground mapping; to be effective it must be used in close cooperation with the geologists responsible for producing the map. A detailed aeromagnetic map increases in value as more becomes known about the geology. The aeromagnetic survey covers an area quickly and provides geologists with an overall picture of structure, even though boundaries may be obscured by overburden, forest, swamp, or water; it reveals major structures and magnetic divisions which may not be recognized in the field and can contribute to mineral or oil exploration programs. It also produces a series of ideas which can be tested by the geologist and which may help him understand more fully the collected geologic data. — *from* Author's abstract

02230 **Boyd, F. R.** The system $CaSiO_3$-$MgSiO_3$-Al_2O_3: Carnegie Inst. Washington Year Book 68, 1968-69, p. 214-221, illus., table, 1970.

02437 **Brabec, Dragan.** Aqua regia-extractable vs. total copper and zinc content of granitic rock [abs.]: Mining Eng., v. 22, no. 1, p. 44, 1970.

02725 **Bretsky, Peter W.** Late Ordovician benthic community structures in St. Lawrence Lowlands, Quebec [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 837, 1970.

02939 **Breusse, J. J.** La prospection géophysique et la recherche des eaux souterraines [Geophysical prospecting and the search for ground water (with English abs.)], *in*

Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 638-640, 1970.

Principal electrical methods applied to ground-water investigations are: resistivity, profiling, resistivity mapping, and electrical sounding; seismic refraction is generally used to complement them. Natural polarization methods have a somewhat restricted use, induced polarization is still controversial, magnetics can be used in special cases, and electromagnetics give uncertain results and have restricted application. Main hydrogeological problems dealt with by geophysics are: alluvial formations, perched water tables, search for basins, sand-dune aquifers, and reconnaissance of aquifers penetrated by saline waters; main structural studies are for delineating horsts, grabens, water sills, granitic sands, and fracture zones. Circulation of karstic waters can rarely be treated by geophysics. Electrical logging methods have wide applications. — *from* Author's abstract

02561 **Brew, Douglas C.** The Naco Formation (Pennsylvanian) in central Arizona: Plateau, v. 42, no. 4, p. 126-138, illus., 1970.

The Naco Formation, a predominantly marine succession of interbedded limestones and terrigenous sedimentary rocks ranging in age from Middle through Late Pennsylvanian, disconformably overlies the Mississippian Redwall Limestone and is thickest in east-central Arizona; it thins northwestward and wedges out laterally and upward into the Supai Formation. The lower ("alpha") member, which represents an ancient regolith partially reworked in Middle Pennsylvanian time, comprises a basal unstratified cherty mudstone or siltstone overlain by stratified terrigenous clastic rocks with lenses of fossiliferous limestone. The "beta" member of fossiliferous beds of limestones and clastics, was deposited by an advancing sea. The "gamma" member, clastic sediments with some interbedded limestones, was formed by progradation of the Supai delta which displaced marine waters southeastward. — *from* Author's abstract

02591 **Briggs, Darinka Z.; Briggs, Louis I.** Geologic-information system — Methodology, design, and objectives [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 837, 1970.

Briggs, Louis I. *See* Briggs, Darinka Z. 02591

Briggs, Louis I. *See* Gill, Dan. 02620

03009 **Brooke, J.; Irving, E.; Park, J.** Remanent magnetism of bore-core in basalt from the Mid-Atlantic Ridge at 45°N [abs.]: EOS, v. 51, no. 4, p. 273, 1970.

02885 **Brooker, Elmer W.** Riverbank stability study at the University of Alberta, Edmonton — Discussion [of paper by S. Thomson, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 170-172, 1970.

Brooker discusses the paper by Thomson (ibid., p. 157-168) and reviews studies of slope stability in various parts of western Canada on Upper Cretaceous shale slopes. He states that for slope-stability studies slope indicators should be installed well in advance of construction, then, if a troublesome zone is defined, piezometric measurements and sampling of soils can be done. — EH

Brooks, C. *See* Krogh, T. E. 02248

02592 **Brosgé, William P.; Tailleur, Irvin L.** Depositional history of northern Alaska [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 837-838, 1970.

02359 **Brown, Edwin T.; Trollope, D. Hugh.** Strength of a model of jointed rock: Am. Soc. Civil Engineers Proc., v. 96, paper 7185, Jour. Soil Mechanics and Found. Div., no. SM2, p. 685-704, illus., tables, 1970.

To extend the presently limited knowledge of the strength of jointed rock masses, triaxial compression tests were made on idealized samples built of gypsum plaster

cubes with sets of preformed discontinuities inclined at various angles to the sample axes. Five sample types were tested at each of 5 confining pressures in the range 0-2000 psi. The four major modes of failure were: axial cleavage fractures at low confining pressures, shear failure through the plaster and across joint planes, slip on joint planes, and ductile failure. Strengths of block-jointed samples failing by mode 2 were less than those of corresponding unjointed samples; at higher confining pressures of mode 4, the strengths were higher than those of unjointed samples, and unaffected by joint orientation. Friction parameters where mode 3 applied were the same as those determined for the plaster in direct shear tests. Mohr's circle envelopes were curved. — *from* ASCE abstract

02940 **Brown, J. M.** Geophysics in United Nations projects [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 651-657, illus., table, 1970.

The geophysical element of U.N. exploration programs in developing countries usually includes an aerial survey followed by ground geophysics with geological and geochemical surveys. Further geophysical surveys may be undertaken to select drilling targets. Operations include investigations for porphyry copper mineralization, iron ores, potassium deposits, geothermal energy, and ground water. Geophysics is also featured in establishment of training institutes and in provision of fellowships. — *from* Author's abstract

Brown, J. M. *See* Mabey, D. 02941

Brown, Merle J. *See* Smith, R. M. 02728

02979 **Brown, R. G.** A biogeochemical survey of the Oracle vicinity, southern Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 62, 1970.

02231 **Bryan, W. B.** Mineralogy of a mugearite from Clarion Island, Mexico: Carnegie Inst. Washington Year Book 68, 1968-69, p. 190-194, tables, 1970.

02232 **Bryan, W. B.** Alkaline and peralkaline rocks of Socorro Island, Mexico: Carnegie Inst. Washington Year Book 68, 1968-69, p. 194-200, tables, 1970.

Bryant, Bruce. *See* Tweto, Ogden. 02416

Bryant, W. R. *See* Morelock, Jack. 02660

02723 **Bukry, D.; Douglas, R. G.; Kling, S. A.; Krasheninnikov, V.** Deep-sea drilling in northern Pacific, paleontology and biostratigraphy [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 838, 1970.

02869 **Bullen, K. E.; Press, F.; Runcorn, S. K.; Collinson, D. W.** (editors). Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, 518 p., illus., tables, 1970.

Papers in this volume were presented at an International Upper Mantle Committee symposium held in Canberra, Australia, January 6-10, 1969. Papers are grouped under the following headings: physics of the mantle; phase transformations in the deep mantle; magmas, xenoliths, and experimental petrology; petrology of the upper mantle and lower crust; and tectonophysics. Twenty-five papers are cited separately. — VSN

02348 **Burek, Peter J.** Magnetic reversals, their application to stratigraphic problems: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1120-1139, illus., tables, 1970.

The stratigraphic consistency of reversely polarized zones, the independence of lithology, and rock magnetic characteristics indicate that the reversed magnetizations in the Lower Triassic of Europe and North America represent reversals of the magnetic field at the time of deposition. — JKP

02376 **Burger, H. Robert, 3d.; Thompson, Margaret D.** Fracture analysis of the Carmichael Peak Anticline, Madison County, Montana: Geol. Soc. America Bull., v. 81, no. 6, p. 1831-1835, illus., 1970.

Analysis of fractures associated with an anticline in upper Paleozoic rocks in Pole Canyon, Madison County, Montana, defines four persistently developed fracture sets: J_I, J_{II}, J_{III}, and J_{IV}. These sets can be interpreted either as two systems of orthogonal regional fractures (J_I-J_{II}, J_{III}-J_{IV}) or as two systems of conjugate shear fractures (J_I-J_{III}, J_{II}—J_{IV}) related to the folding process. Interpretation of the systems as shear fractures is favored on the basis of their relationship to the fold axis. Compression and tension (C and T) axes calculated from calcite petrofabric analysis of limestone samples collected from the anticline correspond to σ_1 and σ_3 directions inferred separately from fracture analysis and confirm a shear origin for both fracture systems. — *from* Authors' abstract

02491 **Burk, Cornelius F., Jr.** Geoscience Data Index available: Oilweek, v. 20, no. 51, p. 10-11, 1970.

The first edition of the Canadian Index to Geoscience Data, in process, will identify available observations and measurements on the geology of Canada, and indicate their physical location, but not record the data themselves. The Geological Survey of Canada, in cooperation with Imperial Oil Ltd. and the Universities of Saskatchewan and Calgary, modified the coordinate indexing IBM system of Imperial to take advantage of new computers. The Streamed Information System-II (SIS-II) made possible a flexible, versatile tool by which can be produced automatically, compilations of stratigraphic, areal, fossil, and autn names, catected or deleted as required. The thesaurus, and specific indexes for the various Canadian provinces, will be made available at reproduction cost. — GDC

02593 **Burk, Cornelius F., Jr.** Devonian reefs in west-central Alberta as revealed by structural analysis of shallow Cretaceous horizon [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 839, 1970.

02936 **Burke, Kenneth B. S.** A review of some problems of seismic prospecting for groundwater in surficial deposits [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 569-578, illus.; discussion, p. 578-579, 1970.

Seismic prospecting is often used in the search for ground-water supplies in surficial deposits. Besides the normal limitations of the method, the problems are: difficulty of generating simple seismic body waves in unconsolidated material, lack of a definitive relation between seismic velocity and a particular deposit; and the greater significance of errors in small-scale seismic investigation. These problems are reviewed, a series of examples illustrates the value of uphole wavefront diagrams in determining the velocity model *in situ*, and problems of using the seismic method to map the water table are considered. Amplitude and frequency studies to remove some restrictions imposed by lack of velocity contrasts, successful on a sand in the USSR, failed in a Canadian experiment probably because of unavoidable changes in shothole characteristics. The possible role of the electroseismic effect in determining permeability is mentioned. — *from* Author's abstract

02821 **Burnham, C. Wayne; Davis, N. F.** Thermodynamic properties of water-bearing magmas [abs.], *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 332, 1970.

02594 **Busch, Daniel A.** Principles of deltaic prospecting [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 839, 1970.

Buseck, Peter R. *See* McNerney, John J. 02980

Bush, John. *See* Baars, D. L. 02584

02840 **Byrd, William D., 2d.** P. R. Spring oil-impregnated sandstone deposit, Uintah and Grand Counties, Utah: Utah Geol. and Mineralog. Survey Spec. Studies 31, 34 p., illus., tables, 1970.

Oil-impregnated lenticular sandstone and siltstone beds in the uppermost Douglas Creek member of the Green River Formation underlie at least 214 sq mi in the southeastern Uinta Basin and may extend northward beneath cover. The top of the oil-impregnated zone is a few to 50 feet below the oil shale zone in the overlying Parachute Creek member. One to five principal saturated zones 3 to 75 feet thick, occur in a 250-ft interval, with the northernmost outcrops under 250 feet of overburden. Average porosity is from 26.6 to 30.5 percent. Calculations indicate 3.7 billion barrels of oil in place. A FORTRAN IV computer program for cross-association of non-numeric sequences was used to help correlate the lenticular stratigraphy in the study area. Cross sections show the lenticular nature of the sands and facies changes in the upper Douglas Creek member. — *from* Author's abstract

02595 **Byrnes, John B.; Colquhoun, Donald J.; Pierce, Jack W.** Importance of tidal-inlet sedimentation in barrier-island systems [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 839, 1970.

02967 **California Dept. Water Resources.** Hydrologic data, 1968 — V. 1, North Coastal area: California Dept. Water Resources Bull. 130-68, v. 1, 73 p., illus., tables, 1970.

The report contains tables showing data on climate, surface-water flow, groundwater levels, and surface- and ground-water quality in the North Coastal area, during the 1967-68 water year. Figures show the location of climatological stations, surface-water measurement stations, surface-water sampling stations, and ground-water basins. — Author's abstract

02968 **California Dept. Water Resources.** Ground water measurement, App. C *in* Hydrologic data, 1968 — V. 5, Southern California, App. A-C: California Dept. Water Resources Bull. 130-68, v. 5, app. A-C, p. 85-423, illus., tables, 1970.

Measurements are given for fluctuation of water level in wells, ground-water levels at wells, and ground-water replenishment during the 1967-68 water year for the six drainage provinces — Central coastal, Los Angeles, Lahontan, Colorado River basin, Santa Ana, and San Diego. — MCM

02565 **Callahan, John.** Determination of source rocks from heavy minerals in residual soils of saprolite Piedmont of North Carolina: Southeastern Geology, v. 11, no. 4, p. 237-251, illus., tables, 1970.

Twenty-five samples of residual soil were taken from five plutonic and metamorphic bodies in the Piedmont of North Carolina. Five of the samples were from a gneissic granite in Vance County, five from an albite granodiorite and five from a diorite in Orange County, and ten from a gabbro-metagabbro complex in Mecklenburg County. Heavy minerals were recovered from half of the samples by panning and from the other half by laboratory separation. The results of the study indicate that it is possible to differentiate between the residual soil samples derived from different rock types on the basis of the weight percentages of the heavy minerals and/or by certain minerals that are diagnostic of a particular rock type. Panning is as effective a method of concentrating heavy minerals as the laboratory technique, and for zircon appears to be more effective. — Author's abstract

02927 **Callahan, William H.; McMurry, H. V.** Geophysical exploration of Mississippi Valley-Appalachian type strata-bound zinc-lead deposits [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 350-360, illus., table, 1970.

It has been the experience of The New Jersey Zinc Company that surface and airborne geophysical methods have not been productive in the detection of anomalies which could be related to the subject type ore deposit and are of limited use in indicating the regional environment favorable for their occurrence in the United

States. Down-the-hole applied potential methods have been helpful in a few cases in indicating trends of environments and of ore and the connection or absence thereof between mineralized holes. Because primary screening of potential areas is commonly done today on a pattern of widely spaced drill holes to delineate environments and to discover ore, the development of down-the-hole geophysical methods seems to offer the most promise for aid in the search for the subject types of deposits. — Author's abstract

02707 **Callison, George.** Trace fossils of trilobites from the Deadwood Formation (Upper Cambrian) of western South Dakota: Southern California Acad. Sci. Bull., v. 69, pt. 1, p. 20-26, illus., 1970.

Tracks of a vagile, epipsammitic trilobite are reported from the Deadwood Formation (Upper Cambrian) of the Black Hills. A new genus, with *Ixalichnus enodius* as the type species, has been established for these tracks. The tracks suggest that *I. enodius* usually swam rather than crawled. This is the first report of tracks of trilobites from the Deadwood Formation. The tracks are associated with a *Cruziana* facies. — Author's abstract

02314 **Cambridge, Thomas R.** Potential of Marmaton oil production: Oil and Gas Jour., v. 68, no. 14, p. 179-183, illus., 1970.

This paper was previously published under the title "Marmaton oil production — Future potential Western Anadarko Basin," Shale Shaker, v. 20, no. 4, p. 64-71, 1969. *See* Abstracts of North American Geology for July 1970. — WBC

02776 **Cameron, Christopher P.; Stone, David B.** Outline geology of the Aleutian Islands with paleomagnetic data from Shemya and Adak Islands — Natl. Sci. Found. Grant GA-1216, Sci. Rept.: Alaska Univ. Geophys. Inst. [Rept.] UAG R-213, 153 p., illus., tables, 1970.

This report reviews the general geology and tectonic setting of the Aleutian Island Arc and presents paleomagnetic results from Tertiary and Quaternary volcanic rocks from Shemya and Adak Islands. Mid-late Tertiary and Quaternary specimens satisfy several criteria of magnetic stability in igneous rocks, and derived pole positions are thought to reflect the ambient geomagnetic field at time of rock origin. By comparison, remanent magnetization of the early Tertiary rocks is less stable and yields uncertain results in terms of pole positions. Paleomagnetic results from the various sites are discussed with respect to the background geology of each island. Paleomagnetic pole positions derived from the results are compared with pole positions from other Tertiary and Quaternary sites in North Pacific tectonic belts. — *from* Authors' abstract

Campbell, Lyle. *See* Kauffman, Marvin E. 02637

02828 **Canada Dept. Indian Affairs** (and Northern Development). Recent and future mineral developments in northern Canada: Polar Rec., v. 15, no. 95, p. 151-166, illus., tables, 1970.

Three of the seven geological provinces of the Canadian Precambrian Shield lie mainly north of lat 60°N — Churchill, which contains the rich Baffin Island iron ores and other deposits; Bear, containing uranium; and Slave which contains Yellowknife and the gold mines. In the Northern Plain and Arctic Lowlands, oil and gas and lead-zinc ores at Pine Point are the most important resources. Oil and gas are major prospects in the eastern Cordillera, and metallic and industrial minerals in the western. The Arctic Lowlands have possibilities for oil, gas and sulfur. Although exploration in the Arctic Coastal Plain is difficult, the discovery of oil at Prudhoe Bay, Alaska, has encouraged the pace. Gold is no longer the main target for exploration, as coal, metals, asbestos, and uranium offer the best promise for production. With respect to oil and gas, northern Canada is virtually unexplored. — MCM

02319 **Canada Geological Survey.** Aeromagnetic series, Iskwasum Lake, Manitoba (2d edition): Canada Geol. Survey Geophysics Paper 2461, scale 1:63,360, 1970; originally published 1963.

02320 **Canada Geological Survey.** Aeromagnetic series, Elbow Lake, Manitoba (2d edition): Canada Geol. Survey Geophysics Paper 2462, scale 1:63,360, 1970; originally published 1963.

02321 **Canada Geological Survey.** Aeromagnetic series, Tramping Lake, Manitoba (2d edition): Canada Geol. Survey Geophysics Paper 2465, scale 1:63,360, 1970; originally published 1963.

02322 **Canada Geological Survey.** Aeromagnetic series, Sheets 26 I/1 and 26 I/2, 26 I/7 and 26 I/8, 26 I/9 and 26 I/10, 26 I/15 and 26 I/16, Baffin Island, District of Franklin: Canada Geol. Survey Geophysics Papers 5451-5454, scale 1:63,360, 1970

02323 **Canada Geological Survey.** Aeromagnetic series, Sheets 26 P/1 and 26 P/2, 26 P/7 and 26 P/8, 26 P/9 and 26 P/10, 26 P/15 and 26 P/16, Baffin Island, District of Franklin: Canada Geol. Survey Geophysics Papers 5455-5458, scale 1:63,360, 1970

02324 **Canada Geological Survey.** Aeromagnetic series, Sheet 27 A/1, Baffin Island, District of Franklin: Canada Geol. Survey Geophysics Paper 5459, scale 1:63,360, 1970

02325 **Canada Geological Survey.** Aeromagnetic series, Cormorant Lake, Manitoba-Saskatchewan (2d edition): Canada Geol. Survey Geophysics Paper 7024, scale 1:253,440, 1970; originally published 1965.

02326 **Canada Geological Survey.** Aeromagnetic series, Hazelton, British Columbia: Canada Geol. Survey Geophysics Paper 7768, scale 1:253,440, 1970.

02327 **Canada Geological Survey.** Aeromagnetic series, File Lake, Manitoba: Canada Geol. Survey Geophysics Paper 8455, scale 1:63,360, 1970.

02768 **Canada Geological Survey.** Geological maps published by the Geological Survey of Canada — Index Sheet 93, British Columbia: Ottawa, Ontario, Geol. Survey Canada, scale 1:1,000,000, revised 1970.

02769 **Canada Geological Survey.** Geological maps published by the Geological Survey of Canada — Index Sheets 29, 39, 49, and 68, 78, District of Franklin: Ottawa, Ontario, Geol. Survey Canada, scale 1:1,000,000, revised 1970.

02461 **Capon, Jack.** Applications of detection and estimation theory to large array seismology: IEEE Proc., v. 58, no. 5, p. 760-770, illus., 1970.

Using statistical theory of signal detection and estimation, the structure of the optimum detector for a known signal and long observation time in additive Gaussian noise is derived. The array processing filter provides a minimum-variance unbiased estimate for unknown input signal, which is the same as the maximum-likelihood estimate of the signal if the noise is a multidimensional Gaussian process. A series of experiments used data from the large aperture seismic array to determine effectiveness of the method relative to simpler methods such as beam-forming; results provide significant conclusions regarding design and processing of data from large seismic arrays. Conventional and high-resolution estimation of the frequency-wavenumber spectrum of the background microseismic noise is presented; diffuse structure of this spectrum aids in explaining relative performance of array processing methods. — *from* Author's abstract

Card, K. D. *See* McIlwaine, W. H. 02508

Card, K. D. *See* McIlwaine, W. H. 02509

Carlson, V. *See* Lennox, D. H. 02935

02771 **Carlson, V. A.** Bedrock topography of the Oyen map-area, NTS 72M, Alberta: [Edmonton, Alberta] Research Council Alberta, scale 1:250,000, 1970.

Inset maps indicate drift thickness (scale about 1 in to 11 mi). An extensive area of glacially contorted bedrock is known to exist in the northeast portion of the map-

area; its upper surface is shown on the bedrock topography map as it was not possible to detect the lower limit from the lithologic logs used. — MCM

02263 **Carr, M. H.** Atmospheric collection of debris from the Lost City fireball [abs.]: EOS, v. 51, no. 7, p. 580, 1970.

02294 **Carrigy, M. A.** Proposed revision of the boundaries of the Paskapoo Formation in the Alberta Plains: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 156-165, illus., 1970.

The nomenclature of the post-Kneehills strata is revised by placing the lower boundary of the Paskapoo Formation at the top of the Kneehills Member (Battle Formation) of the Edmonton Formation in central Alberta. The redefined Paskapoo Formation thus becomes equivalent to the Willow Creek Formation of southwestern Alberta and now includes the Lance-equivalent beds and the Cretaceous-Tertiary transition. Evidence is presented to show that the Porcupine Hills Formation is much more extensive than formerly mapped and that it overlies the Paskapoo Formation in the vicinity of Calgary. — Author's abstract

02706 **Carrigy, M. A.** Silica sand in the vicinity of Edmonton, Alberta: Research Council Alberta Rept. 70-1, 30 p., illus., tables, 1970.

Eighteen samples of quartzose sand collected from dune deposits near Edmonton, to determine their suitability for glass manufacture, were screened, washed, and analyzed for Si, Al, Fe, Ca, and M. Preliminary analyses indicated that 5 samples merited further treatment involving heavy liquid and magnetic separation, and acid leaching to determine the lower limits of Fe removal. Test results suggest that simple washing and screening treatments will upgrade approximately 50 percent of the sand to meet specifications for manufacture of fibreglass, green and amber containers, and possibly some types of window glass. Limits of Si and Fe contents after heavy liquid and magnetic separation, and acid leaching appear to be 95-96 percent Si, 2-3 percent Al, and 0.15-0.20 percent Fe. — *from* Author's abstract

02596 **Carrigy, Maurice A.** Deltaic sedimentation in Athabasca tar sands [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 840, 1970.

02571 **Carson, C. D.; Kunze, G. W.** New occurrences of tabular halloysite: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 538-540, illus., tables, 1970.

Four soils from three widely separated geographic locations [Florida, Guatemala, Texas] contain tabular halloysite as a major constituent in the $< 0.2\mu$ clay fraction. This clay mineral type common to these soils has a moderately high surface area and cation exchange capacity and occurs in small hexagonal plates. — Soil brief

02569 **Carstea, D. D.; Harward, M. E.; Knox, E. G.** Comparison of iron and aluminum hydroxy interlayers in montmorillonite and vermiculite — Pt. 1, Formation; Pt. 2, Dissolution: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 517-526, illus., tables, 1970.

Acid conditions favor formation of interlayers except for iron interlayers in vermiculite, favored by alkaline conditions. Al-interlayered montmorillonite with X-ray characteristics of chlorite was sensitive to pH; this material was much less like chlorite after 6 months. Other Al interlayers showed increased formation after 6 months or 1 year. Iron interlayers deteriorated with time. Stability of hydroxy-Al and -Fe interlayers depended on kind of mineral matrix and hydroxy interlayer, and conditions of acidity under which they were formed. Residual 14A line on some samples after dithionite-citrate and NaOH treatments may result from resolution of collapsible or noncollapsible components. Changes in properties of clay systems resulting from dissolution treatments must be recognized. — *from* Soil briefs

02391 **Carter, James L.** Mineralogy and chemistry of the Earth's upper mantle based on the partial fusion-partial crystallization model: Geol. Soc. America Bull., v. 81, no. 7, p. 2021-2034, illus., tables, 1970.

Consideration of phase diagrams, mineralogical and chemical data, and textural evidence suggests that ultramafic and mafic nodules found in basaltic rocks at Kilbourne Hole, New Mexico, were formed by the interaction of partial fusion-partial crystallization processes. The model proposes that the original upper mantle olivine composition falls in the Fa 12 percent to Fa 14 percent interval. Calculated upper mantle mineralogy and chemical compositions are given. — *from* Author's abstract

Casey, Richard E. *See* Bandy, Orville L. 02586

Caulfield, David D. *See* Faas, Richard W. 02615

Chagnon, J. Y. *See* LaRochelle, P. 02898

02730 **Chalcraft, Richard G.** Petrography and geophysics of the Rock Hill gabbro pluton, York County, South Carolina: Southeastern Geology, v. 11, no. 3, p. 153-171, illus., table, 1970.

A 16 sq mi gabbroic pluton near Rock Hill, South Carolina, is a member of a series of gabbro bodies intruded into the Charlotte belt, probably during Late Paleozoic time. Petrologic data indicate that the amount of plagioclase decreases from 95 percent at the center to 57 percent toward the contacts. Chemical alteration of primary minerals to hydrated secondary minerals is believed to have been caused by a hydrothermal fluid derived from the parental magma. Gravity and magnetic surveys were undertaken to obtain information on contact relationships and thickness respectively. Magnetic survey data indicated that the pluton is relatively thin. The density contrast between gabbro and adjoining rocks was not always sufficient to warrant supposition concerning the location of the contact. — *from* Author's abstract

Chan, K. M. *See* Manheim, F. T. 02652

02715 **Chang, T. P.; Toebes, G. H.** A statistical comparison of meander planforms in the Wabash Basin: Water Resources Research, v. 6, no. 2, p. 557-578, illus., tables, 1970.

The planforms of two natural meandering rivers, the Wabash River and the White River in Indiana, were investigated using a variety of statistical techniques. Local curvature series were used as the basic statistical descriptor of the planform. Two groups of factors, (1) geology and soil and (2) flow rate and channel slope, were found to be major factors that control the meander planform. This conclusion was supported by probability distribution as well as by time series analysis studies. A method of moving spectrums was developed for the analysis of nonstationary data that are typical in geomorphology. This method was applied to the curvature series of the White and Wabash rivers. It appears to provide an objective way to describe local statistics of the meander shape. — Authors' abstract

Chao, E. T. C. *See* Bell, P. M. 02227

02763 **Chapman, Carleton A.** The geology of Acadia National Park: New York, Viking Press, 128 p., illus., geol. map, 1970.

Chapman, Peter. *See* Blinn, John C., 3d. 02851

02233 **Chayes, F.** The simplified or idealized "Skaergaard" model: Carnegie Inst. Washington Year Book 68, 1968-69, p. 200-201, 1970.

02234 **Chayes, F.** Experimentation in the electronic storage and manipulation of large numbers of rock analyses: Carnegie Inst. Washington Year Book 68, 1968-69, p. 174-186, illus., table, 1970.

02788 **Chenoweth, Philip A.** Geology of oil and gas occurrence in Pennsylvanian rocks, Mid-Continent region [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 840, 1970.

02541 **Chmelik, Frank B.; Bouma, Arnold H.** New logging technique will speed ocean bottom surveys: Ocean Industry, v. 5, no. 5, p. 56-59, illus., 1970.

Electrical logging is an economical, fast and efficient method of obtaining data on the soft, unconsolidated, fine-grained marine sediments on the ocean bottom, can be done almost anywhere, and does not require a drilling ship. Electrical logs can be used to acquire information on bulk density, porosity, resistivity, conductivity and other aspects of sediments, and will have useful applications for pollution studies, engineering, and mining of the ocean floor. — EH

02311 **Churkin, Michael, Jr.** Canada basin-speculations on origin: Oil and Gas Jour., v. 68, no. 16, p. 186-187, 190, 194, 196, illus., 1970.

A re-evaluation of the Paleozoic rocks, particularly Devonian and older, adjacent to the deep Canada basin of the Arctic Ocean north of Alaska, coupled with recently acquired geophysical data, causes the author to reject the theory that the basin developed by subsidence of a Precambrian shield and to propose that it is a true, probably very ancient, ocean basin floored by oceanic crust and rimmed by an early Paleozoic geosynclinal belt. If the Paleozoic stratigraphic belts of northern Alaska extend into the Canadian Arctic Islands, then parts of these islands and the Mackenzie River delta are excellent areas for petroleum exploration. — WBC

Churkin, Michael, Jr. *See* Eberlein, G. Donald. 02332

02597 **Churkin, Michael, Jr.** Correlation of fold belts of Alaska, Canada, and Siberia [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 841, 1970.

02598 **Clack, W. J. F.** Transport and deposition of carbonate-reef sand, windward coast, Carriacou, West Indies [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 841, 1970.

02440 **Clark, K. F.** Characteristics of disseminated molybdenum deposits in the western Cordillera of North America [abs.]: Mining Eng., v. 22, no. 1, p. 45, 1970.

Clark, L. D. *See* James, H. L. 02780

Clark, R. *See* Bogard, D. D. 02270

02599 **Clark, Robey H.; Rouse, John T.** Closed system for generation and entrapment of hydrocarbons in Cenozoic deltas, Louisiana Gulf Coast [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 841, 1970.

02777 **Clark, William B.** Gold districts of California: California Div. Mines and Geology Bull. 193, 186 p., illus., tables, 1970.

Although gold is found in many areas in California, the most productive districts are in the northern and central portions of the Sierra Nevada where primary deposits usually consist of gold-quartz veins in metamorphic rocks; placer deposits are either Tertiary or Quaternary stream deposits. In the Klamath Mountain province, largest sources have been the streams of the Klamath-Trinity River system. Basin Ranges and Mojave Desert provinces have yielded substantial amounts from either epithermal deposits in zones of Tertiary volcanic rocks or in mesothermal quartz veins of metamorphic and granitic rocks; some gold has been recovered from placers also. Moderate amounts have been mined in the Transverse and Peninsular Ranges, and the Modoc Plateau province; small amounts have been produced in the Coast Ranges. [A map in pocket locates gold districts.] — *from* Author's abstract

02969 **Clark, William B.** Platinum: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 6, p. 115-122, illus., 1970.

The geology and mineralogy of platinum are described briefly. Primary platiniferous deposits are found chiefly in basic and ultrabasic intrusive igneous rocks, with the platinum metals sometimes associated with nickel and copper and sometimes with chromite. Geologic sketch maps and descriptions of the Bushveldt Complex in Trans-

vaal and the Sudbury District in Ontario are included. Deposits in both areas occur in lopoliths. Platinum found in California is a by-product of placer gold mining. A map of California shows locations of platinum finds and the distribution of ultrabasic igneous rocks, chiefly serpentine. Feasible areas for prospecting and geochemical exploration methods are described, as well as recovery, refining techniques, and production. — EH

02265 **Clarke, R. S., Jr.; Jarosewich, E.; Nelen, J.** The Lost City, Oklahoma, meteorite [abs.]: EOS, v. 51, no. 7, p. 580, 1970.

Clayton, Lee. *See* Moran, Stephen R. 02502

02503 **Clayton, Lee.** Olfactory factors in landscape evolution [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 4, 1970.

02600 **Cleary, W. J.; Conolly, J. R.** Provenance model studies, Piedmont rivers to Atlantic deep-sea floor [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 841-842, 1970.

02365 **Cohenour, Robert E.** Sheeprock granite, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 31, 1970.

The Sheeprock granite in the Sheeprock Mountains in southeastern Tooele County intrudes rocks ranging in age from Precambrian through Silurian; a rhyolite dike cuts the granite along its southwest margin. The following ages have been obtained: Pb-α age of 20 m.y. for zircon, 15 m.y. for monzonite, K-Ar age of 19 m.y. on biotite, and Pb-α age of 13 m.y. for zircon, all from the granite; and a Pb-α age of 12 m.y. for the rhyolite dike. The concordance of these ages is considered satisfactory and the absolute age of the stock is thought to be about 19 m.y. — MCM

02905 **Coker, A. E.** Application of remote sensing to occurrence of collapse sinkholes in the Alafia and Peace River basins, Florida, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 22A1-22A14, illus. [1970].

This study deals with methods of anticipating sinkhole collapse by using remote sensing to identify, delineate and study relic features related to collapse. From a reconnaissance made from 1967 remote-sensing data, test sites in the study area in Polk County, Florida, were chosen for the February 1968 flight, based on their high probability of collapse. Photography and infrared scanner imagery were used and compared. Patterns of plant stress, due to moisture deficiency, and moisture differences in soils over sinkholes may be located and delineated by thermal-contrast features shown on infrared imagery films. — EH

Collinson, D. W. *See* Bullen, K. E. 02869

Colquhoun, Donald J. *See* Byrnes, John B. 02595

Condrate, R. A., Sr. *See* Levitt, S. R. 02998

Connors, Roland A. *See* Karner, Frank R. 02736

Conolly, J. R. *See* Cleary, W. J. 02600

02911 **Conrod, A. C.; Short, H. A.** Ocean bottom surveying with aerial photography, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 46A1-46A17, illus. [1970].

Studies of the application of photography and spectrography to ocean surveying have been made. Photographic tests run to date show that good bottom detail may be obtained at depths ranging in some cases to more than 25 meters, and biological and

geological features can be seen and interpreted. The method shows promise as a survey tool for examining the near-shore environment and in studying land-sea interactions, both natural and artificial. Spectrometric experiments in cooperation with Woods Hole Oceanographic Institute have shown that the kinds and amounts of suspended and dissolved water may be estimated with airborne radiometers. Uses of photography versus electro-optical imaging systems for possible operational use on ERSP and EROS satellites are mentioned. Design and application aspects of nonphotographic imaging systems are discussed. — Author's abstract

02790 **Cook, H. E.** Miette platform evolution and relation to overlying bank ("reef") localization, Upper Devonian, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 842, 1970.

02385 **Cook, P. J.** Repeated diagenetic calcitization, phosphatization, and silicification in the Phosphoria Formation: Geol. Soc. America Bull., v. 81, no. 7, p. 2107-2116, illus., 1970.

Investigation of diagenesis in the Meade Peak Member of the Phosphoria Formation reveals a number of replacements involving repeated phosphatization, calcitization, and silicification. I believe that the replacements resulted primarily from responses to pH changes, some of which took place within the sediments soon after deposition. The presence of CO_2 probably is important in making possible the replacement of apatite by calcite. The study shows that given the right physio-chemical conditions, phosphate is a relatively mobile diagenetic constituent of sediments. — Author's abstract

Cooper, J. A. *See* Rancitelli, L. A. 02272

02432 **Cooper, J. D.** The demand picture for high-quality clays [abs.]: Mining Eng., v. 22, no. 1, p. 42, 1970.

Cosgrove, J. F. *See* Persiani, C. 02965

02933 **Costello, J. T.; Norquay, I. P.** Logging the Prairie evaporite formation in Saskatchewan [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 492-496, illus., 1970.

The use of well-log data for the estimation of sylvite, carnallite, halite and clay content has been made on many exploration and development potash projects. A recently introduced Sidewall Epithermal Neutron (SNP) device will aid the basic program. The effect of well-bore variables and the presence of chlorine is diminished with this device. The effect of these variables on the SNP system and upon older well logs is discussed. A guide to the use of older logs is included. — Authors' abstract

02988 **Cotera, Augustus S.** Wave tank experiment for beach models [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 75-76, 1970.

02580 **Cramer, Howard Ross.** Structural features of the Coastal Plain of Georgia — A correction [to 1969 paper]: Southeastern Geology, v. 11, no. 3, p. 203, 1970.

The Charlton High, proposed earlier, should be abandoned in favor of the term Orange Island, created for an area in southeastern Georgia where an uplift has resulted in the removal of Oligocene rocks. — HRC

Crawford, C. B. *See* Mitchell, R. J. 02894

02271 **Cressy, Philip J., Jr.** Cosmogenic radionuclides in the Lost City meteorite [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

02601 **Cross, Aureal T.; Thompson, Gary G.** Some aspects of paleoecology and stratigraphy of lower Mancos Shale (Upper Cretaceous) of Colorado and Utah, based on palynologic analysis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 842, 1970.

02445 **Cubit, John.** A simple piston corer for sampling sand beaches: Limnology and Oceanography, v. 15, no. 1, p. 155-156, illus., 1970.

A hand-operated corer with nonstationary piston is easily made from two rubber stoppers and two lengths of pipe or tubing. It can be used for taking samples in sand beaches to depths greater than 1 meter, depending mainly on length of coring tube and depth of sand. Since its penetrating ability depends on water drawn through the sand, the corer works better in most wet sands than in dry. — VMJ

Cvancara, A. M. *See* Moran, Stephen R. 02502

02602 **Dahlstrom, Clinton D. A.** Structural geology in eastern margin of Canadian Rocky Mountains [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 843, 1970.

02741 **Dailey, Donald H.** Some new Cretaceous foraminifera from the Budden Canyon Formation, northwestern Sacramento Valley, California: Cushman Found. Foram. Research Contr., v. 21, pt. 3, p. 100-111, illus., 1970.

Twenty-one new species and one new subspecies of foraminifera collected from strata of probable Barremian-early Cenomanian age of the Budden Canyon Formation exposed along the northwestern edge of the Sacramento Valley, California, are described and illustrated. These species are a portion of a moderately rich microfauna, as yet undescribed, most species of which have been reported previously from distant regions. Present in the samples is the genus *Reinholdella*, recorded for the first time from the western hemisphere, and *Spiroplectinata* and *Falsoguttulina* which have never been reported previously from the Pacific Coast of North America. — Author's abstract

Damon, Paul. *See* Hashad, A. H. 02367

Daniels, R. B. *See* Gamble, E. E. 02548

Daniels, R. B. *See* Gamble, E. E. 02577

Danner, W. R. *See* Nestell, M. K. 02664

Darnell, Richard P. *See* Meeves, Henry C. 02738

Dash, B. P. *See* Mabey, D. 02941

Davies, David K. *See* Berg, Robert R. 02587

02789 **Davies, David K.; Ethridge, Frank G.** Recognition of depositional environments through thin-section analysis of detrital sediments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 843, 1970.

02801 **Davies, David K.** Environments of sandstone deposition in the Claiborne Group, *in* Outcrops of the Claiborne Group in the Brazos Valley, southeast Texas — Geol. Soc. America South-Central Sec., 4th Ann. Mtg., 1970, Guidebook: [College Station, Tex.] Texas A and M Univ., Dept. Geology, p. 17-21, illus., 1970.

Sediments of the Claiborne Group were deposited in a variety of nearshore marine and coastal plain environments. Fluctuations of the shoreline during the Middle Eocene, caused by migrations of fluvial, fluvio-deltaic and barrier complexes on the margins of a subsiding basin, resulted in vertical stacking of sediments from contrasted depositional environments. A high degree of lateral and vertical variability is the rule even within individual sandstone formations of the Claiborne. Outcrops of fluvial, deltaic and marine (barrier) sandstones are described. — EH

02519 **Davies, J. C.** Western Peninsula area (east sheet), District of Kenora: Ontario Dept. Mines Prelim. Geol. Map P. 604, scale 1 in. to 1/4 mi., text, 1970.

A stratigraphic sequence from mafic to felsic metavolcanics to metasediments is repeated twice in the Western Peninsula area. Gold occurrences are associated with

quartz veins in sheared volcanic or granitic rocks; gold values are erratic. Pyrite is abundant in graphitic argillite; that in rhyolite may indicate the presence of sulfides associated with nearby peridotite. — MCM

02838 **Davis, C. E.; Ahmad, N.; Jones, Robert L.** Weight loss on ignition and K fixation in clays: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 345-347, illus., tables, 1970.

A significant correlation (r^2=0.65***) was obtained for K fixation and loss on ignition in a number of soil clays of contrasting mineralogy and reference clay minerals when samples to which K was added were heated hydrothermally (moisture saturated environment) and by dry heat from 100°C to 380°C. Potassium fixation induced by this treatment resulted in reduction of loss on ignition values. — Soil brief

Davis, G. L. *See* Krogh, T. E. 02246

Davis, G. L. *See* Krogh, T. E. 02247

Davis, G. L. *See* Krogh, T. E. 02248

Davis, N. F. *See* Burnham, C. Wayne. 02821

02268 **Davis, Raymond, Jr.** The argon radioactivities in the Lost City meteorite and the spatial intensity of cosmic radiation [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

03011 **Dawson, Mary R.; Black, Craig C.** The North American cricetid rodent "*Eumys*" *exiguus*, once more: Jour. Paleontology, v. 44, no. 3, p. 524-526, illus., 1970.

Characters of the Oligocene cricetid "*Eumys*" *exiguus* are reviewed, and it is concluded that, contrary to a recent statement of its relationships [Alker, 1968], the species does not belong to the European genus *Paracricetodon*. As had been previously suggested, it represents the most primitive member of the North American genus *Scottimus*. — Authors' abstract

02504 **Deal, D. E.; Huff, D. M.** Hydrodynamic interpretations of Holocene sediments along the Turtle River, northeastern North Dakota [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 6, 1970.

Deere, Don U. *See* Nordlund, Reymond L. 02358

02848 **Dellwig, L. F.** Pluses and minuses of radar in geological exploration, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 14-1 — 14-17, App. p. 14A1-14A25, illus., tables [1970].

The greatest advantage of using radar in geological investigations is in mapping remote areas where climatic conditions are adverse to ground and aerial photography, since side-scanning systems can obtain imagery regardless of daylight or weather conditions. Radar is especially valuable in regional studies for gross topographic and structural representation. In detailed studies its value lies in distinguishing topographic features, vegetation, fracture and other patterns. Use of multifrequency radar, now in the experimental stage, is potentially valuable. Present drawbacks of radar, which will soon be reduced or eliminated include look-direction dependency, impractibility of mosaicking slant-range imagery, radar shadowing in areas of high relief, distortion caused by slant-range presentation, and displacement of elevated features caused by layover. — EH

02603 **DeMille, George.** Geology of hydrocarbon occurrence in Woodbend reefs (Devonian) of western Canada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 843-844, 1970.

02604 **Dennison, John M.** Petroleum related to Middle and Upper Devonian deltaic facies in central Appalachians [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 844, 1970.

02479 **Deschenes, Jean-Marc.** The history of the genus *Acer*, a review [with French abs.]: Naturaliste Canadien, v. 97, no. 1, p. 51-59, table, 1970.

This article is a review of previously published papers on the origin, the migration, and the development of the genus *Acer* with special emphasis on sugar maple (*Acer saccharum*) in North America. It traces the time and region of origin, the migration routes to North America, the speciation, the effect of glaciation, and the post-glacial events up to the present time. — Author's abstract

02556 **DeVoto, R. H.; Stevens, D. N.; Bloom, D. N.** Dawsonite and gibbsite in the Green River Formation: Mines Mag., v. 60, no. 5, p. 17-21, 1970.

The Green River Formation of Eocene age in the Piceance Creek Basin of northwestern Colorado is of lacustrine origin and composed predominantly of mudstone, marlstone, and dolomite. Dawsonite $NaAl(OH)_2CO_3$ and gibbsite $Al(OH)_3$ are concentrated in beds ranging from 50 to 500 feet thick in an area of about 500 square miles and form a huge potential resource of soluble extractable aluminum. Kerogen in these same beds contain an average of 25 gallons of oil per ton of rock.

Dickerson, J. D. *See* Lyles, Leon. 02862

02490 **Dietz, Robert S.; Holden, John C.; Sproll, Walter P.** Geotectonic evolution and subsidence of Bahama platform: Geol. Soc. America Bull., v. 81, no. 7, p. 1915-1927, illus., 1970.

The thick (> 5 km) section of flat lying Cretaceous and younger carbonates capping the Bahama platform implies a geotectonic history characterized by great subsidence. A basement of oceanic crust is postulated to underlie the platform. The interpreted tectonic history is as follows: Triassic rifting creating a small ocean basin was accompanied by rotation of the North American plate away from North Africa and by shearing across the top of the South American plate, which remained attached to Africa. The resulting sphenochasm was filled with turbidites. During renewed expansion of the North Atlantic the Bahama platform became a subsiding marginal plateau attached to the North American craton. This interpretation improves the fit of continental drift reconstruction, and is compatible with geophysical evidence for thick clastic section beneath the carbonates. — *from* Author's abstract

Digby, P. J. *See* Murrell, S. A. F. 02718

02876 **Dilcher, David L.; Pavlick, Raphael J.; Mitchell, James.** Chlorophyll derivatives of middle Eocene sediments: Science, v. 168, no. 3938, p. 1447-1449, illus., 1970.

Chloroform extracts of middle Eocene brown coal were made; the chlorophyll derivatives obtained were separated chromatographically. The visible light spectrum, chromatographic behavior, HCl number, infrared spectrum, and mass spectrum on one of the pigments extracted is indicative of methyl pheophorbide a. This is the oldest occurrence of fossil phorbins reported. — Authors' abstract

02467 **Dinga, Carl F.** A quantitative analysis of the effect of Earth rotation of certain parameters of meandering alluvial rivers: Illinois Geog. Soc. Bull. v. 12, no. 2, p. 1-28, illus., table, 1970.

The study cites concepts of the effect of the Coriolis force on river channels and adjacent topography and investigates the influence of the Earth's rotation on parameters of meandering alluvial rivers. Measurements of right- and left-hand radius, turning arc, meander length and flood-plain areas for 28 river segments in the United States were compiled. Quantification and evaluation of the data indicate that the Earth's deflective force is a measurable factor in the formation of the meanders. Time is also an important factor in determining the influence of the Coriolis force. Radii of right-hand turns are smaller than those of left-hand turns in the Northern Hemisphere, but right-hand turning arcs are greater than left-hand ones in the number of degrees through which a meander bends. — EH

Disrud, L. A. *See* Lyles, Leon. 02862

Doan, Arthur S., Jr. *See* Walter, Louis S. 02267

02929 **Dodd, Philip H.; Droullard, Robert F.; Lathan, Carl P.** Borehole logging methods for exploration and evaluation of uranium deposits [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 401-415, illus., 1970.

Borehole logging is the geophysical method most extensively used in the United States for exploration and evaluation of uranium deposits; gamma-ray logs, commonly supplemented with a single-point resistance log, currently supply about 80 percent of basic data for ore reserve calculation and much of subsurface geologic information. Calibration and quantitative analysis of the gross gamma-ray log to obtain equivalent grade and thickness of ore intersections are based on proportionality between the area under the log curve and product of the mean equivalent grade and thickness of a radioactive layer. Rock density and related parameters are calculated from gamma-gamma logs; a different technique permits cancellation of natural radioactivity to obtain density data from ore zones. Computer programs are used to analyze gamma-ray and gamma-gamma logs to obtain equivalent grade, thickness and bulk density. Natural gamma-ray spectroscopy offers significant additional techniques for exploration and evaluation. — *from* Authors' abstract

Doherty, Patrick C. *See* Wright, Thomas L. 02389

02928 **Doig, Ronald.** Current research in the application of natural and induced radioactivity to mineral exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 389-400, illus., tables, 1970.

Modern techniques of exploration for uranium, thorium, and potassium are reviewed, with special emphasis on the evaluation of deposits in the field, using spectrometric techniques that until recently have been confined to the laboratory. The usefulness of the various types of radiation detectors is discussed, with methods of interpreting results. Techniques have recently been developed for the field analysis of nonradioactive materials using various activation methods, notably the use of X-ray fluorescence and neutron activation. Elements that have been successfully analyzed at levels useful in mineral exploration include tin, copper, zinc, lead, nickel, iron, molybdenum, beryllium, aluminum, silver and possibly gold. — Author's abstract

02926 **Dolan, William M.** Geophysical detection of deeply buried sulfide bodies in weathered regions [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 336-343, illus.; discussion, p. 343-344, 1970.

In many areas of the world where deeply weathered overburden prevails, e.g., the southwest U.S.A., geophysical detection of sulfide ore occurrences has major economic significance. Induced polarization (IP) methods have been effective in deeply weathered areas, particularly for detection of disseminated sulfides. However, there is a type of sulfide occurrence that rarely lends itself to detection by IP. That is the stringered or massive discrete sulfide occurrence of relatively small volume. When such occur at depths greater than their effective radii, detection becomes very difficult. Yet they can have considerable value. The application of electromagnetic (EM) methods to the problem is discussed. The applicability of time-domain EM methods to partially solving the problem is indicated. Depth penetration of as much as four times the radius of the target is considered feasible under certain circumstances. — Author's abstract

02606 **Dole, Hollis M.** 1970's, now or never decade for minerals and fuels [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 844, 1970.

02607 **Donaldson, Alan C.; Kanes, William H.** Tectonic controls on late Paleozoic sedimentation in western West Virginia [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 844, 1970.

02235 **Donnay, G.; Preston, H.** Progress report on ewaldite: Carnegie Inst. Washington Year Book 68, 1968-69, p. 288-290, illus., table, 1970.

02236 **Donnay, G.; Pawson, D. L.** X-ray study of echinoderm skeletons: Carnegie Inst. Washington Year Book 68, 1968-69, p. 296-297, 1970.

02237 **Donnay, Gabrielle.** Further use of the Pauling-bond concept: Carnegie Inst. Washington Year Book 68, 1968-69, p. 292-295, illus., table, 1970.

02238 **Donnay, Gabrielle.** Fifty years of X-ray crystallography at the Geophysical Laboratory, 1919-1969: Carnegie Inst. Washington Year Book 68, 1968-69, p. 278-283, 1970.

02708 **Donnay, Gabrielle; Stewart, J. M.; Preston, H.** The crystal structure of sonoraite, $Fe^{3+}Te^{4+}O_3(OH)H_2O$ [with German abs.]: Tschermaks Mineralog. u. Petrog. Mitt., 3d ser., v. 14, no. 1, p. 27-44, illus., tables, 1970.

Sonoraite is monoclinic, $P2_1/c$, with $a = 10.984(2)$, $b = 10.268(2)$, $c = 7.917(2)$A, $\beta = 108.49(2)°$. An automated diffractometer was used to collect 1,884 independent reflections which were corrected for absorption. The structure was determined by an automated symbolic addition procedure, and refined to a residual of 6.2 percent. Chains of octahedra about Fe extend along [101]; edge-sharing pairs are joined by corner sharing. Fe-Fe distances across shared edges are 3.05 and 3.20 A, short enough to suggest magnetic interactions. All but one H_2O are involved in the chains. The Te^{4+} ions have a pseudotetrahedral coordination, with three oxygen ions forming one face of the tetrahedron and the lone electron pair of Te occupying the fourth corner. The O-Te-O average bond angle is 95°. The Fe chains are tied together by Te-O bonds in all three dimensions. — *from* Authors' abstract

02424 **Donnell, John R.; Blair, Robert W., Jr.** Oil shale resources of selected rich zones in the Green River Formation [abs.]: Mining Eng., v. 22, no. 1, p. 39, 1970.

02808 **Dorf, Erling.** The fossil forests of Yellowstone Park: Sci. and Children (Washington, D.C., Natl. Sci. Teachers Assoc.), v. 7, no. 6, p. 15-17, illus., 1970.

Information on the unique fossil forests of Yellowstone National Park include history, unique characteristics, absence of fossilized animal remains, nature of the volcanic rocks, the process of petrifaction, and geologic age. Four references are given for further reading. — MCM

Dorjes, Jurgen. *See* Reineck, Hans-Erich. 02672

02608 **Dott, R. H., Jr.** Limitations in paleocurrent analysis of trough cross-stratification [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 844-845, 1970.

Douglas, A. G. *See* Andersland, O. B. 02420

Douglas, R. G. *See* Bukry, D. 02723

02609 **Douglass, Raymond C.** Pennsylvanian fusulinids from southeastern Alaska [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 845, 1970.

Dowdy, Emily. *See* Tully, Philip C. 02839

02925 **Dowsett, John S.** Geophysical exploration methods for nickel [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 310-319, illus., tables; discussion, p. 310-321, 1970.

Nickel-bearing sulphide deposits are currently the major source of the world's nickel. These sulphide deposits are commonly more conductive, more magnetic, and heavier than their environment and thus are detectable by geophysical means. The most widely used methods in the Canadian Precambrian Shield are the electromagnetic and magnetic methods. Induced polarization, self potential, and gravity surveys are useful in exploration for small bodies under shallow overburden. Induced polarization surveys are also useful in the search for weakly disseminated sulphide bodies. In some tropical and subtropical areas electromagnetic techniques are not effective as salt laden moisture in the overburden and weathered rock makes these formations

very conductive. Where these conditions prevail, induced polarization, magnetic and geochemical methods are the most effective. — Author's abstract

02520 **Dreimanis, A.** Pleistocene geology of the St. Thomas area (east half), southern Ontario: Ontario Dept. Mines Prelim. Geol. Map P. 606, scale 1:50,000, text, 1970.

Quaternary drift, 100-300 feet thick over most of the St. Thomas area, is underlain by Middle Devonian limestone of the Dundee and Detroit River Formations. No Pleistocene deposits older than those of the last or Wisconsin ice age have been encountered. The oldest glacial deposit, the Carfish Creek Drift, is mainly silty sand till. Main economic deposits are gravel and gravelly sand; lacustrine clays have been used for making bricks. — MCM

02887 **Dreimanis, A.** Effect of groundwater levels on stress history of the St. Clair clay till deposit — Discussion [of paper by L. G. Soderman and Y. D. Kim, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 188-189, illus., 1970.

Dreimanis discusses the paper by Soderman and Kim (ibid., p. 173-187) and suggests two causes of overconsolidation of clay till in the Windsor-Tilbury areas: (1) lowering of the ground-water table which caused the development of the oxidized overconsolidated crust, probably due to dry climate 11,000 to 9,000 years ago and to lowering of lake levels in the Great Lakes Region, and (2) the upper 40 feet of the < 100-ft thick clay till is a separate till layer with already initially differing properties, a higher calcite-dolomite ratio, and a higher preconsolidation than the underlying portion of the entire till unit. — EH

02429 **Dreyer, Robert M.** Evaluation of lateritic bauxite and nickel deposits [abs.]: Mining Eng., v. 22, no. 1, p. 41, 1970.

02356 **Drnevich, Vincent P.; Richart, F. E., Jr.** Dynamic prestraining of dry sand: Am. Soc. Civil Engineers Proc., v. 96, paper 7160, Jour. Soil Mechanics and Found. Div., no. SM2, p. 453-469, illus., 1970.

The application of vibratory shearing strains to soil under static confining pressure, tests on Ottawa sand in a torsional resonant column apparatus, demonstrated that material behavior may be significantly changed by prestraining. At shearing strains between 0.001 and 0.01 percent it can double the dynamic shear modulus and damping, strikingly reduce the static compressibility, and cause fatigue failures. No changes occur at shearing strains less than 0.001 percent. The effects depend on confining pressure, void ratio, shearing strain amplitude, and cycles of vibration. Millions of cycles may be necessary to produce these changes. Test results indicate that density or void ratio measurements may not reveal the total change in parameters imparted to dry sand by vibratory loading. This is important in determining dynamic response of foundations and compaction improvement of sand soils. — *from* ASCE abstract

Droullard, Robert F. *See* Dodd, Philip H. 02929

02751 **Drugg, Warren S.** Two new Neogene species of *Tuberculodinium* and one of *Xenicodinium* (Pyrrhophyta): Biol. Soc. Washington Proc., v. 83, no. 9, p. 115-121, illus., 1970.

Three new species of dinoflagellate cysts are described. *Tuberculodinium wallii* n.sp. is from samples of post-Miocene age from JOIDES core hole 5, on the Florida-Hatteras Slope about 150 km east of Jacksonville, Fla. The tract is discoidal; the endof endophragm, about 1μ thick, forms a central body 87-117μ, with dorsal and ventral areas ornamented by small spherical processes, and 6 to 14 spherical and cup-shaped processes on the periphery supporting the membranous periphragm; the operculum has three precingular plates. *T. vancampoae* (Rossignol) Wall, from the same samples, has opercular plates of different shape and lacks processes on dorsal and ventral surfaces. *T. rossignolae* n.sp., lower Miocene, and *Xenicodinium hispidum* n.sp., middle Miocene to Pliocene, are from wells in north-central Sumatra. — VMJ

02610 **Drummond, Kenneth J.** Geology and oil potential of Canadian Arctic Islands [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 845, 1970.

02313 **Duff, Denny E.** Thoughts on petroleum prospects in The Maritimes, Pts. 1-2: Oil and Gas Jour., v. 68, no. 11, p. 218-224; ibid., no. 12, p. 98, 100, 102, illus., table, 1970.

This article summarizes the general geology and structure of Anticosti Island, Gaspé, New Brunswick, Nova Scotia, Prince Edward Island and adjacent areas of the Atlantic Ocean and Labrador Sea and comments on petroleum possibilities and exploration history of each area. Only a minor amount of oil and gas has been found, but prospects for The Maritimes are enhanced by the multiplicity of structural and stratigraphic combinations offered by Tertiary and Cretaceous strata offshore and Mississippian strata onshore and by the nature of petroleum occurrences found to date. — WBC

02463 **DuMontelle, Paul B.** Geologic investigation of the site for an environmental pollution study: Illinois Geol. Survey Environmental Geology Note 31, 19 p., illus., tables, 1970.

In connection with the Illinois Natural History Survey's plan to create an environmental pollution study area, the Illinois State Geological Survey studied the geology of the site on the University of Illinois campus at Champaign. Data from 27 borings are included in an appendix; water content, compressive strength, clay mineralogy and grain size data for 30 push samples are included. The proposed site is located on the south slope of the Champaign Moraine with an unsorted matrix of clay, silt and sand, with imbedded pebbles, cobbles and some large boulders. Colluvium deposits are 3 to 15 feet thick, with water content 16 to 30 percent and compressive strength 1 to 2 tons per sq ft. Sand and silt, and brown and gray till which underlie them are described. It is concluded that the site chosen is geologically feasible; some precautions to be taken in constructing it are outlined. — EH

Duncan, James M. *See* Dunlop, Peter. 02357

02611 **Dunham, Robert J.** Keystone vugs in carbonate beach deposits [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 845, 1970.

02357 **Dunlop, Peter; Duncan, James M.** Development of failure around excavated slopes: Am. Soc. Civil Engineers Proc., v. 96, paper 7162, Jour. Soil Mechanics and Found. Div., no. SM2, p. 471-493, illus., table, 1970.

Nonlinear analyses by the finite element method of the stresses around slopes excavated in clay have been used to determine where failure begins and how the failure zone enlarges as excavation continues. The stress-strain and strength characteristics are represented by means of stress-strain curves in two lines, and the analyses are conducted in a series simulating successive stages of excavation. The results show that location of the first failure and manner in which its zone enlarges depends on the initial stress conditions before excavation and manner in which shear strength of the clay varies in depth. The analyses indicate that development of failure around slopes excavated in overconsolidated clay is considerably different from that around slopes in normally consolidated clay. — *from* ASCE abstract

02333 **Durham, David L.** Geology of the Sycamore Flat and Paraiso Springs quadrangles, Monterey County, California: U.S. Geol. Survey Bull. 1285, 34 p., illus., tables, geol. maps, 1970.

Plutonic and metamorphic rocks of the pre-Tertiary basement complex crop out in northern and western Sycamore Flat and Paraiso Springs quadrangles. An overlying conformable stratigraphic sequence comprises: Tierra Redonda Formation (sandstone with middle Miocene marine fossils); Monterey Shale (mudstone); Pancho Rico Formation (Pliocene, sandstone with marine fossils locally); and Paso Robles Formation (Pliocene and Pleistocene(?) chiefly fuiviatile conglomerate and sandstone). The area lies in a re-entrant that disrupts the NW-trending structural grain of

the Coast Ranges with more nearly E- and W-trending structural features. The steep NE-facing scarp of the Sierra de Salinas is generally attributed to uplift of the mountain block along the concealed King City fault; the Reliz fault is probably either a continuation or a branch of the King City. At least 19 wells were drilled for oil before July 1968. The small Monroe Swell oil field, on the east border of the Paraiso Springs quadrangle, produced about 70,000 bbl oil from 1959-66. — *from* Author's abstract

02890 **Dussault, R.; Larocque, G. S.; Ouimet, J. M.** Outardes 4, barrage principal [Outardes 4, main dam (with English abs.)]: Canadian Geotech. Jour., v. 7, no. 1, p. 16-36, illus., tables, 1970.

The following article deals with the design and construction of the main dam at the Outardes 4 development [58 miles north of Baie Comeau on the St. Lawrence River]. The structure is an earth and rockfill dam reaching a maximum height of 400 feet (about 121.9 m). The characteristics of the site, the choice of the type of structure, the principal properties of the materials, the typical cross-section, and stability analysis are either mentioned or described. The construction and control methods are discussed and a brief description of the instrumentation in the dam is also given. — Authors' abstract

Dymond, J. R. *See* Garlick, G. D. 02397

02999 **Eaton, Gordon P.; Watkins, Joel S.** The use of seismic refraction and gravity methods in hydrogeological investigations [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 544-568, illus., tables, 1970.

Geophysical methods that provide information on porosity, thickness, and shape of unconsolidated deposits are techniques for search and evaluation in hydrogeology. Two types of deposits are considered: river valleys filled with fluvial sediments, stratified drift, or glacial till; and intermontane basins filled with poorly consolidated fan gravels and sheet flood deposits. Under ideal circumstances, the seismic method provides a means of determining the three-dimensional geometry, gross stratigraphy, and local lithofacies variations of the aquifer; and depth to the water table. The gravity method can be used alone as a reconnaissance tool for evaluating bedrock topography beneath the aquifer in some areas, and locally for quantitative estimates of depth to bedrock. Used with the seismic method or with borehole data, surface measurements of gravity provide a means of determining average field porosity of the deposit and, in some instances, even a measure of specific yield. — *from* Authors' abstract

02332 **Eberlein, G. Donald; Churkin, Michael, Jr.** Paleozoic stratigraphy in the northwest coastal area of Prince of Wales Island, southeastern Alaska: U.S. Geol. Survey Bull. 1284, 67 p., illus., geol. map, 1970.

Richly fossiliferous Paleozoic marine sedimentary and volcanic rocks that represent every system from Ordovician to Pennsylvanian and that have an aggregate thickness of at least 35,000 feet are described and divided into 10 newly named formations. In ascending order, these are the Descon Formation (Ordovician, Silurian), Heceta Limestone (Silurian), Karheen Formation (Silurian, Devonian), Coronados Volcanics (Devonian), Wadleigh Limestone (Devonian), Port Refugio Formation (Devonian), Peratrovich (Mississippian), and Klawak (Pennsylvanian) Formations, and the Ladrones Limestone (Pennsylvanian). In addition the name St. Joseph Volcanics is applied to a lithologically distinctive assemblage of probable Devonian volcanic rocks. The age and stratigraphic relationships are poorly known. — GDE

Ebert, Janet. *See* Hornberger, George M. 02716

02484 **Ebright, J. R.** Ohio wells head for the cellar: Oil and Gas Jour., v. 68, no. 21, p. 108-109, 112-114, illus., 1970.

This paper gives a brief description of the results of exploration for petroleum in Cambro-Ordovician rocks in eastern Ohio with emphasis on recent drilling. The illustrations include isopach maps of the Beekmantown and Rose Run. — WBC

Edgar, A. D. *See* Piotrowski, J. M. 02557

02612 **Edgar, N. Terence.** Deep-Sea Drilling Project, future program [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 845-846, 1970.

02443 **Edmondson, W. T.; Allison, David E.** Recording densitometry of X-radiographs for the study of cryptic laminations in the sediment of Lake Washington: Limnology and Oceanography, v. 15, no. 1, p. 138-144, illus., 1970.

X-radiographs of cores of sediment from Lake Washington [Wash.] reveal prominent laminations not visible to the eye. Measurement of the film density with a recording densitometer provides an exact and objective record of these laminations. The strongest band, at a depth of about 16 cm in the central part of the lake, is attributed to the lowering of the lake level in 1916. The mean rate of deposition therefore has been about 3.1 mm per year. The most prominent bands more recent than 1916 are too few to be annual, but the fine structure of these bands shown by the densitometer record may result from annual variations in deposition. The film density is strongly correlated with the dry weight and mineral residue of the sediment. — Authors' abstract

Ehrlich, Marvin. *See* Snow, D. T. 02433

02390 **Eisbacher, G. H.** Deformation mechanics of mylonitic rocks and fractured granites in Cobequid Mountains, Nova Scotia, Canada: Geol. Soc. America Bull., v. 81, no. 7, p. 2009-2020, illus., 1970.

Mylonitization in the southern part of the Cobequid Mountains resulted from deformation of igneous and sedimentary rocks during the Devonian Acadian orogeny. Detailed analyses of mineral lineation, penetrative s-surfaces, and mineral grain fabrics suggest that uniform tectonic flow within the mylonite zone produced rock strains with extension parallel to the mineral lineation. Quartz fabrics originated when large quartz crystals deformed into elongate granular aggregates. A regional compression axis, inferred from a laminar flow model for the mylonite zone, is compatible with a compression axis derived from slickensided fractures in granitic rocks north of the mylonite zone. The subhorizontal, southeasterly trending compression axes are perpendicular to the regional trend of the Appalachians mountain chain in Nova Scotia. — Author's abstract

El Goresy, A. *See* Bell, P. M. 02229

02746 **El-Shatoury, H. M.; Whelan, J. A.** Mineralization in the Gold Hill mining district, Tooele County, Utah: Utah Geol. and Mineralog. Survey Bull. 83, 37 p., illus., tables, 1970.

The Gold Hill area, in Tooele County, northwest Utah, is one of the oldest mining sites in the state. Principal minerals removed since 1857 are lead, copper, silver, gold, arsenic, zinc and tungsten. This area lies in the east central part of the Great Basin section of the Basin and Range Province. The sediments, severely thrusted, comprise a relatively complete stratigraphic sequence from Lower Cambrian through Lower Triassic. They have been intruded by a quartz monzonite stock and porphyry dikes, and include acidic lavas and pyroclastics of Tertiary age. Evaluation of the potential for the district shows that, based on current information, most of these minerals are present in quantities too small for large scale commercial exploitation. This area contains impressive quantities of beryllium; the writers postulate that the beryllium is in feldspar. The low grade of the mineralization makes it uneconomical at this time to mine it. — Authors' abstract

02286 **El-Shatoury, Hamad.** Gold Hill mining district, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 27, 1970.

Lead-alpha ages of 471 and 499 m.y. obtained for zircon from the Gold Hill monzonite stock are obviously anomalous since the stock intrudes rocks of the Pennsylvanian-Permian Oquirrh Formation; Nolan (1935) believed the stock to be Tertiary.

A K-Ar age of 8.0 ± 0.8 m.y. was applied to adularia from beryllium-bearing quartz-carbonate-adularia veins that cut the Gold Hill stock. — MCM

02383 **ElSwaify, S. A.; Ahmed, S.; Swindale, L. D.** Effects of adsorbed cations on physical properties of Tropical Red and Tropical Black Earths — [Pt.] 2, Liquid limit, degree of dispersion, and moisture retention: Jour. Soil Sci., v. 21, no. 1, p. 188-198, illus., table, 1970.

The liquid limits, degrees of dispersion, and moisture retention of a Tropical Red Earth, predominantly kaolin and iron oxides, were independent of the nature of the saturating cation. The same properties of a Tropical Black Earth, largely montmorillonite, were dependent upon the nature of the saturating cation, with Na giving the highest and K the lowest influence. Ca and Mg gave intermediate and essentially equal values. Unexpected behavior due to K saturation is explained by specific adsorption of K in a manner similar to but weaker than irreversible fixation. Linear regression equations were derived to express the dependence of the three properties on the saturating cations, and show that the four cations examined were acting independently. — *from* Authors' abstract

02547 **El-Swaify, S. A.; Swindale, L. D.** Effects of saline water on the chemical properties of some tropical soils: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 207-211, illus., tables, 1970.

The original acidities of Low Humic Latosol and a Tropical Red Desert from Hawaii were resistant to saline water leaching. Neither soil tended to accumulate salts from percolating solutions. In general the valence-dilution effect was observed. At high electrolyte concentration the soils showed higher affinities for divalent cations than predicted by the US Salinity regression equation. Assuming large surface charge densities, predictions based on the theory of the diffuse double layer described more closely the high affinities of these soils for calcium ions. — Soil brief

02861 **El-Swaify, S. A.** The stability of saturated soil aggregates in certain tropical soils as affected by solution composition: Soil Sci., v. 109, no. 3, p. 197-202, illus., 1970.

Wet sieving was used to evaluate the changes in aggregate size distribution of a Low Humic Latosol and a Tropical Red Desert resulting from treatment with specified electrolyte solutions. Results showed that subsurface soils underwent no structural change as a result of treatment with sea water and NaCl, $CaCl_2$, $MgCl_2$ in concentrations of 0 to 0.6 N. The structure of surface soils, which are less stable during hydraulic conductivity measurements, were also unaffected by these chemical treatments. — JWH

02613 **Embry, A. F., 3d; Klovan, J. E.** Upper Devonian biostromes and bioherms on northeastern Banks Island, Northwest Territories [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 846, 1970.

02280 **Eng, Morris.** Gravel, gift of the glaciers: Conserv. Volunteer, v. 33, no. 190, p. 15-21, illus., 1970.

This popular account of gravel in Minnesota describes the processes of the Wisconsin Ice Stage that produced glacial till in various sections of the state: kame deposits near Buck Hill, Hill City, and New Brighton; eskers near Finlayson, Little Falls, and Cloquet; and glacial lakes. Gravel uses, ground water in glacial aquifers, and recreational uses of gravel pits and deposits are discussed. — MCM

England, J. L. *See* Bell, P. M. 02229

02523 **Eno, Gene.** The contribution of the amateur to earth science education in the midwest [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 33, 1970.

02614 **Erdogan, Solmaz Z.; Perkins, Bob F.** Biofacies relations in Buda Limestone (Comanche Series, Cretaceous) of west and Trans-Pecos Texas, paleogeographic and paleobathymetric implications [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 846, 1970.

02239 **Erlank, A. J.; Kushiro, I.** Potassium contents of synthetic pyroxenes at high temperatures and pressures: Carnegie Inst. Washington Year Book 68, 1968-69, p. 233-236, table, 1970.

02953 **Ermanovics, I. F.** Precambrian geology of Hecla-Carroll Lake map-area, Manitoba-Ontario (62P E1/2, 52M W1/2): Canada Geol. Survey Paper 69-42, 33 p., illus., tables, geol. map, 1970.

This report describes an area of Archean rocks east of Lake Winnipeg. Basic to intermediate lavas, irrupted onto a gneissic terrain, and psammitic and pelitic rocks deposited on a basement of lava, were intruded by granodiorite. Mineralization associated with quartz veins cutting the older sedimentary and volcanic rocks occurred 2,720 ± 185 m.y. ago. Later periods of intrusions resulted in other groups of igneous rocks, the youngest being massive quartz monzonite. With the closing of San Antonio gold mine in 1968, active mining in the area ceased, but claim-development work is active in most areas underlain by granodiorite rocks adjacent to metasedimentary and volcanic rocks. — Author's abstract

02719 **Espach, Ralph.** O.C.G.S.-A.I.P.G. introductory geology course for secondary teachers, a volunteer public service effort: Shale Shaker, v. 20, no. 6, p. 116-117, illus., 1970.

The Oklahoma City Geological Society and local members of the American Institute of Professional Geologists have been conducting an evening course for teachers of high school students in Oklahoma City. The course plan was laid out by Fred DeLuca of Oklahoma University's School of Geology and Geophysics; materials were furnished free or at cost by the Oklahoma Geological Survey, and visual aid equipment and meeting place by the City Public School system. Twelve geologists, consultants as well as company personnel, have delivered lectures, each volunteering their time and experience to provide exceptional two-hour classes in subjects which span the entire geologic spectrum. An arrangement was made for college credits to be earned by those who wished to further their formal education. Attendance was supplemented by members of the local gem and mineral society, den mothers, and other interested individuals. — GDC

02754 **Estes, Richard; Berberian, Paul.** Paleoecology of a Late Cretaceous vertebrate community from Montana: Breviora, no. 343, 35 p., illus., tables, 1970.

At least 78 species from 5 classes of vertebrates occur at the Bug Creek Anthills location, in the Hell Creek Formation, McCone County, Montana; the fauna closely resembles that from the Lance Formation of Wyoming. Quantitative paleoecological techniques showed that the Bug Creek fishes, aquatic salamanders, and mammals are more abundant than the turtles, dinosaurs, and lizards when compared with the Lance fauna. The Bug Creek fauna was deposited in relatively deeper waters of rivers coming from lowland swamps. Gar and bowfin fish and elongated salamanders are dominant in the aquatic community nearest the site of deposition; some of the mammals were part of the riverbank community. Compared with a modern southern Louisiana community, the Cretaceous fauna may be about two-thirds of the original diversity. — *from* Authors' abstract

02835 **Estes, Richard.** New fossil pelobatid frogs and a review of the genus *Eopelobates*: Harvard Univ. Mus. Comp. Zoology Bull., v. 139, no. 6, p. 293-340, illus., tables, 1970.

This genus lived in North America during the Eocene and early Oligocene and possibly the Cretaceous; it is here retained in the Megophyrinae. Two lines may be distinguished in the genus: a primitive short-skulled group from North America, with some from Europe; and the long-skulled group from Europe. The spadefoot toads were probably derived from *Eopelobates*, the earliest true spadefoot being from the early and middle Oligocene of North America. Another form was present in the early Oligocene of Europe, further implying an Eocene divergence of the spadefoots from megophyrines. The modern megophyrines are tropical and subtropical and probably diverged from an *Eopelobates*-like form no later than the Cretaceous. — *from* Author's abstract

Ethridge, Frank G. *See* Davies, David K. 02789

02971 **Euler, Robert C.** Late Pleistocene paleoclimatology of Grand Canyon [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 22, 1970.

02524 **Evrenos, A. I.** Operations research in petroleum exploration [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 33, 1970.

02615 **Faas, Richard W.; Caulfield, David D.** Determination of bulk properties of saturated sediments through spectral analysis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 846, 1970.

02394 **Fåhraeus, Lars E.** Conodont-based correlations of Lower and Middle Ordovician strata in western Newfoundland: Geol. Soc. America Bull., v. 81, no. 7, p. 2061-2076, illus., tables, 1970.

Lower and Middle Ordovician conodont faunas in western Newfoundland contain forms that occur in the Balto-Scandian sequence. The lower boundary of the Table Head Formation probably lies within strata corresponding to the British *Didymograptus bifidus* Zone and corresponds to a level tentatively regarded as the base of the Aluoja Substage. The upper boundary of the middle Table Head corresponds to a rather high level in the Lasnamägi Stage (in the upper part of the *Didymograptus murchisoni* Zone). Studies of conodonts from the Table Head, the Cow Head Group, and the uppermost St. George Formation, and comparisons with conodonts from the Fort Peña, the Joins and Levis Formations, indicate that the North American *bifidus* Zone is at least partly equivalent to the British *bifidus* Zone, hence supporting the correlation suggested by Berry (1960). — *from* Author's abstract

02990 **Fanfani, L.; Nunzi, A.; Zanazzi, P. F.** The crystal structure of fairfieldite: Acta Cryst., v. B26, pt. 5, p. 640-645, illus., tables, 1970.

Fairfieldite is triclinic, space group $P\bar{1}$ confirmed; cell dimensions are determined from small crystals from Foote mine, North Carolina. The cell content is $Ca_2Mn(PO_4)_2 2H_2O$. The crystal structure, solved from a 3-dimensional Patterson function and refined by successive Fourier syntheses and least-squares to an R value 0.075, consists of infinite chains of Mn octahedra and P tetrahedra running along the *c* axes. Calcium ions occupy vacant spaces between chains connecting them in a 3-dimensional network. The structure of the fairfieldite group is closely related to that of the krohnkite group — in both, the same chain motif with strictly similar connection of tetrahedra and octahedra inside the chain. Differences are in the reciprocal array of the chains, which are shifted in the *c* direction by different amounts in the two groups. — *from* Authors' abstract

02543 **Fanning, D. S.** Cave features — Information concerning the nature and genesis of soils: Soil Sci. Soc. America Proc., v. 34, no. 1, p. 98-104, illus., table, 1970.

Many caves are shallow and contain plant roots. Patterns of cave development and stalactite growth [in Maryland, Virginia, and West Virginia] show how rock structure controls the pattern of water movement in rocks and soils. Better specimens of some secondary minerals may be obtained from caves than from soils. Speleothem growth increments may result from seasonal fluctuations in the rate of flow and composition of percolating waters. — Soil brief

02895 **Farvolden, R. N.; Nunan, J. P.** Hydrogeologic aspects of dewatering at Welland [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 194-204, illus., 1970.

Realignment of the Welland Canal and the building of underpass structures necessitated both temporary and permanent depressurizing of an artesian aquifer of fractured dolomite found beneath 60 to 100 feet of poorly-permeable glacial till and lacustrine sediments. A contour map of the original piezometric surface constructed from drillers' records showed a normal ground-water flow system where movement was from local upland recharge areas to local discharge areas along the Welland River and the existing canal. A contour map of the drawdown was also drawn. Analysis of the cone-of-depression and of pre-engineering pumping tests provided values

for aquifer coefficients required for solution of unsteady flow equations. Because coefficients used were average values for a relatively small area extrapolated over a broad area, predicted drawdown showed considerable variations in reliability. — *from* Author's abstract

Fehrenbacher, J. B. *See* Frazee, C. J. 02549

02616 **Feugére, G.** Gasmap, a method of geochemical prospecting [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 846-847, 1970.

02240 **Finger, L. W.; Rapp, G. R., Jr.** Refinement of the crystal structure of triphylite: Carnegie Inst. Washington Year Book 68, 1968-69, p. 290-292, tables, 1970.

02241 **Finger, L. W.** Refinement of the crystal structure of an anthophyllite: Carnegie Inst. Washington Year Book 68, 1968-69, p. 283-288, illus., tables, 1970.

Fireman, Edward L. *See* Spannagel, Gert. 02269

02983 **Fisher, D. Jerome.** Twinning in pegmatitic microcline perthite [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 65, 1970.

Fisher, Jane S. *See* Kennard, William C. 02750

02617 **Fitzgerald, J. D.; Gagnon, P. M.** Using computerized well-data system [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 847, 1970.

02937 **Flathe, H.** Interpretation of geoelectrical resistivity measurements for solving hydrogeological problems [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 580-597, illus., 1970.

Many endeavors have been made to utilize fully geoelectrical sounding graphs recorded by resistivity in the interpretation. Two- and three-layer diagrams in the form of sets of master curves allow, in combination with auxiliary point diagrams, an approximate physical interpretation provided the principle of equivalence is sufficiently observed for the geological situation and good field measurements are not influenced by secondary effects. The possibility for a rapid and exact computation master curve for horizontal *n*-layer cases with arbitrary resistivities permits a full utilization of total information content of a measured graph. Case histories from humid and arid areas illustrate how, by geoelectrical resistivity measurements, hydrogeological problems may be cleared up using a suitable combination of available methods of interpretation, in particular in the search for and delimitation of aquifers, and fixation of the fresh-water/salt-water boundary underground. — *from* Author's abstract

02709 **Flawn, Peter T.** Mineral resources and conservation in Texas: Texas Univ. Bur. Econ. Geology Geol. Circ. 70-1, 20 p., illus., table, 1970.

Single and multiple land use as related to mineral extraction is described; emphasis on sequential multiple use, in which the land is restored for subsequent use after mineral extraction or other single land use has taken place is recommended. The majority of land in Texas is privately owned, and there are no State conservation laws, and very few Federal ones, applying to mines or mining. The Federal government should formulate a rational and consistent mineral and mining policy, but the State should establish its own control mechanisms. A review of the mineral extraction situation in Texas emphasizes the type of mine, method of mining, waste disposal, the effect of mining on the environment, and the potential effects of ground-water withdrawals on the environment. — EH

02767 **Flawn, Peter T.** Environmental geology — Conservation, land-use planning, and resource management: New York, Harper and Row, 313 p., illus., tables, 1970.

02784 **Flawn, Peter T.; Turk, L. J.; Leach, Carolyn H.** Geological considerations in disposal of solid municipal wastes in Texas: Texas Univ. Bur. Econ. Geology Geol. Circ. 70-2, 22 p., illus., table, 1970.

The authors discuss in general terms the geologic and hydrogeologic conditions favorable and unfavorable for sanitary landfills, and describe geologic formations and surface- and ground-water conditions, suitable for such landfills, which occur within 25 miles of the major cities of Texas. Of 26 cities covered, some are lumped in categories such as: cities of the black prairies, cities of the coastline margin, and cities of the high plains. The other cities are treated individually. — EH

02371 **Fleck, R. J.** Tectonic style, magnitude, and age of deformation in the Sevier orogenic belt in southern Nevada and eastern California: Geol. Soc. America Bull., v. 81, no. 6, p. 1705-1720, illus., table, 1970.

A detailed study of Late Cretaceous deformation in the northern Spring Mountains reveals a penetrative deformation involving thrust faulting and folding that produced as much as 40 miles of crustal shortening. The tectonic style suggests a genetic relationship between folds and thrust faults. The lack of stratigraphic control of thrust surfaces, the pervasive nature of the deformation, and the continuation of thrusts into Precambrian crystalline rocks are considered inconsistent with decollement or gravity-slide origins, but the presence of a deep-seated *Abscherungzone* is consistent with observations. Thrust faulting was confined to a period between approximately 75 and 90 m.y., although folding probably began somewhat earlier. — *from* Author's abstract

02301 **Fletcher, Calvin D.** Extinct bison — Shirley Basin Mining District: Earth Sci. Bull., v. 3, no. 1, p. 5-9, illus., 1970.

During stripping operations at Kerr-McGee Corporation's North Walker mine, Shirley Basin mining district, the remains of at least six large extinct bison, found approximately 14 feet below the surface, have been tentatively identified as those of *Bison antiquus figginsi*, described in some literature as *Bison Taylor*, a large bison that became extinct near the end of the Pleistocene. It appears that the bison and enclosing deposits, containing flint chips and hide scrapers, may predate the presence of man in North America. The artifacts may have come from younger stream channels which cut into the top of the Pleistocene sediments at several places, but the position of this zone halfway down the pit face prevented careful examination. — EH

02374 **Flynn, Clinton J.** Post-batholithic geology of the La Gloria-Presa Rodríguez area, Baja California, Mexico: Geol. Soc. America Bull., v. 81, no. 6, p. 1789-1806, illus., geol. map, 1970.

Resting on and derived from a basement complex of Upper Jurassic-Lower Cretaceous metavolcanic rocks intruded by granitic plutons are: conglomerates of the Upper Cretaceous Redonda Formation (new name); shales, mudstones, and sandstones of the Upper Cretaceous Rosario Formation; conglomerates, sandstone, mudstone and shale of the Eocene Buenos Aires and Delicias Formations (new names); sandstones and basalts of the Miocene Rosarito Beach Formation; and Pliocene-Pleistocene conglomerates and sandstones. [Guide fossils are given.] — *from* Author's abstract

02962 **Fok, Yu-Si.** One-dimensional infiltration into layered soils: Am. Soc. Civil Engineers Proc., v. 96, paper 7343, Jour. Irrigation and Drainage Div., no. IR 2, p. 121-129, illus., tables, 1970.

An equation in algebraic form has been developed to describe one-dimensional infiltration into layered soils. The effect of soil properties upon the infiltration process is readily observable in this equation. This equation can be reduced to an equation describing infiltration into *homogeneous* soil by considering the soil profile as being one layer. The validity of this developed equation has been shown by the study of two cases of two-layered soils. Good agreement between published and computed infiltration data is obtained. — ASCE abstract

02415 **Folger, D. W.** Wind transport of land-derived mineral, biogenic, and industrial matter over the North Atlantic: Deep-Sea Research, v. 17, no. 2, p. 337-352, illus., tables, 1970.

Concentration of mineral grains, phytoliths, fresh-water diatoms, fungus spores and opaque spherules was measured in air and surface water samples collected in the North Atlantic between Barbados-Gibraltar-Plymouth, U.K. and between Plymouth-U.K.-New York. Along the northerly track highest concentrations were in the western Atlantic. Most clay and silt-sized material was carried to the equatorial Atlantic by trade winds and to midlatitudes by westerly winds. Marine currents are apparently responsible for much of it over and near the continental shelf edge. Differences in kind and abundance of biogenic particulates characterize the two areas of the Atlantic. Phytoliths and fresh-water diatoms were most abundant in equatorial regions; fungus spores were dominant in midlatitudes. [Data should provide criteria for interpretation of the marine sedimentary record.] — *from* Author's abstract

02749 **Folsom, Michael M.; Winters, Harold A.** Drainage orders in Michigan: Michigan Academician, v. 2, no. 3, p. 79-91, illus., tables, 1970.

Streams and drainage systems may be treated as discrete elements for separate observations, which may provide an objective and quantitative approach to understanding of the form and origin, as well as the functional and distributional relationships of such features within the landscape. The 8,604 discrete stream segments recognized in Michigan were treated by the modified Horton stream-ordering system and tabulated. It is shown that organization within drainage systems, as recognized by the Horton logarithmic relation between stream orders and numbers of segments, exists in the southern peninsula. Plots of bifurcation ratios for an aggregate of all segments show an orderly organizational structure, but individual streams may depart from mean conditions. According to the data, extreme bifurcation ratios involving either the master order or the next lowest order are always associated with long and narrow drainage basins. — ESL

02957 **Foote, R. S.** Radioactive methods in mineral exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 177-190, illus., 1970.

Current measurements utilize spectral composition of gamma radiation to differentiate between radiation from decay of natural U, Th, and K, and to remove contributions from cosmic radiation and fission fallout. Airborne measurement of the U daughter product Bi-214, Th daughter product Tl-208, and k-40 normalized to constant surface elevation provide intensity and radiation balance profiles and isoradiation maps indicating trend of soil types, and allow lesser anomalous radiation to be identified. Various sizes of NaI(Tl) detectors have been used for surface and airborne measurements; data have been measured as 400-channel spectra with readout of record sequence number, surface altitude and time on to high-speed magnetic tape. Computer-controlled plotting of isoradiation maps and of composite radiation profiles provides maps compatible with geologic data. Examples of data reduction of mineralization in a phosphate-enriched region are given; correlations of gamma-radiation types with certain minerals are shown. — *from* Author's abstract

02618 **Forgotson, James M., Jr.; Stark, Philip H.** Well-data files and computer, exploration tools for the 70s [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 847, 1970.

02963 **Forstén, Ann-Marie.** Variation in and between three populations of *Mesohippus bairdii* Leidy from the Big Badlands, South Dakota: Acta Zool. Fennica 126, 16 p., illus., tables, 1970.

Three samples of cheek teeth of [the equid] *Mesohippus bairdii* from three ecologically different habitats of the Lower Nodular zone, Oligocene, are compared. There are some statistically significant differences in size and proportions, and some slight differences in visual morphology, probably due to sample error. The taxonomy of the Chadronian species of *Mesohippus* according to [J.] Clark, et al. (1967) are discussed, and compared to the ecological samples. — Author's abstract

02298 **Fox, Richard C.** A bibliography of Cretaceous and Tertiary vertebrates from western Canada: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 263-281, 1970.

02553 **Francis, C. W.; Tamura, Tsuneo; Bonner, W. P.; Amburgey, J. W., Jr.** Separation of clay minerals and soil clays using isopycnic zonal centrifugation: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 351-353, illus., 1970.

The technique of isopycnic zonal centrifugation in a continuous nonaqueous density gradient was used in the purification and separation of standard clay minerals and soil clays. A suspending agent (polyvinylpyrrolidone) compatible with tetrabromoethane and ethanol stabilized clay suspensions produced multiple banding of systems which otherwise flocculated into one band. Data from X-ray diffraction analyses revealed the technique is useful in purification of clay minerals and identification of clay minerals in soil clays; however, the banding obtained from the clay fraction of a Dodge silt loam did not represent discrete bands of specific clay minerals. — Authors' abstract

02468 **Fraunfelter, George H.** Cephalaspids from the Middle Ordovician Platteville Limestone: Illinois Acad. Sci. Trans., v. 63, no. 1, p. 14-17, illus., 1970.

The remains of exoskeleton parts of Ostracoderms, cephalaspids, were collected from the Platteville Limestone (Middle Ordovician-Black Riveran) in two quarries near Dixon, Lee County, Illinois. The two best specimens, which are figured and described, consist of one medium-sized individual with most of the head shield, a pectoral fin and part of the trunk preserved, and one large disarticulated pectoral fin. The specimens appear to belong to species of the Order Osteostraci, Family Hemicyclaspididae (Ateleaspidae). The remains are dolomitized and, hence do not retain the structures of bone as viewed in thin section. — Author's abstract

02549 **Frazee, C. J.; Fehrenbacher, J. B.; Krumbein, W. C.** Loess distribution from a source: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 296-301, illus., tables, 1970.

The distribution of loess from a source is defined by an additive exponential model derived in this study [along six Peoria loess traverses in Illinois and Indiana] based upon the particle size changes with distance from the source. Leeward of the source, two changes in the rate of loess thinning occurred. The change closest to the bluff is related to particle size differences with distance from the source. The second change is attributed to greater loess deposition in a wider zone near the source by winds from different directions. Windward of the source only one change in rate of loess thinning occurred. This change is related to loess deposition by winds of different directions rather than by particle size differences. — Soil brief

02717 **Freeze, R. Allan.** Moire pattern techniques in groundwater hydrology: Water Resources Research, v. 6, no. 2, p. 634-641, illus., 1970.

The moire pattern technique provides a conceptual or teaching tool that can be applied to problems involving the superposition of potential field solutions. Moire interference also forms the basis of a measurement technique that can be adapted for use with the membrane analogy for groundwater flow. — Author's abstract

02827 **Frey, Fred A.** Rare earth abundances in alpine ultramafic rocks, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 323-330, illus., tables, 1970.

Rare-earth (RE) abundances of some alpine ultramafic rocks have been determined. A variety of RE distributions were observed; high-temperature peridotites are markedly depleted in the light RE. [Detailed studies of the high-temperature peridotite at Lizard, Cornwall, is cited as an example.] Mineral RE abundances imply that the RE are located in structural sites of the host minerals, and observed distributions can be used to develop a partial melting model for basalt generation. The residue mineralogy of this model is not consistent with residue mineralogies proposed to explain basaltic major element composition. — *from* Author's abstract

Frey, Robert W. *See* Howard, James D. 02633

Frey, Robert W. *See* Reineck, Hans-Erich. 02672

Friedman, Gerald M. *See* Schroeder, Johannes H. 02678

02846 **Friedman, Jules D.** Thermal anomalies and geologic features of the Mono Lake area, California, as revealed by infrared imagery, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 11-1 — 11-76, illus., tables [1970].

In the Mono Lake area, California, are exposures of a variety of lithologies having different physical and thermal properties and textural and morphologic features. Infrared surveys were made in 1965 and 1966 to measure variations in infrared emissions from the surface in the 4.5μ to 5.5μ and 8μ to 14μ bands. Areal variations were registered on film as differences in image tonal density. Variations of surface radiant temperatures with time during the diurnal cycle were also recorded. Contrasting thermal patterns included: thermal anomalies caused by convective heat loss, daytime radiant-temperature differences resulting from variations in the incident radiant solar flux as a function of surface microrelief and morphology, and nighttime radiant-temperature differences resulting from contrasts in physical and thermal properties of lithologic units and water. — *from* Author's abstract

02401 **Friedman, M.; Perkins, R. D.; Green, S. J.** Observation of brittle-deformation features at the maximum stress of Westerly Granite and Solenhofen Limestone: Internat. Jour. Rock Mechanics and Mining Sci., v. 7, no. 3, p. 297-306, illus., table, 1970.

The nature and sequence of deformation in the region of maximum stress were investigated in specimens deformed in uniaxial stress compression at room temperature at constant strain rates from 10^{-4}/sec to 10^{3}/sec. Microscopic observations show that no visible fracture (> 0.01 mm long) or other evidence of deformation takes place until > 99 percent of average maximum stress at a strain rate of 10^{-4}/sec is attained by the granite. Detailed examination of an incipient shear fracture in a granite specimen suggests that the fracture is formed by coalescence of links between en echelon inclined grain boundaries and cleavages. Photographs taken during loading in the split-Hopkinson bar device illustrate that macroscopic shear fractures develop before extension fractures in the sequence of events leading to gross failure of the specimens. — Authors' abstract

02896 **Frind, E. O.** Theoretical analysis of aquifer response due to dewatering at Welland [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 205-216, illus., 1970.

The investigation of regional response of an aquifer to depressurization at the Welland Canal construction site is discussed. A two-dimensional, horizontal mathematical model is developed representing the nonhomogeneous continuum of the aquifer by a finite number of nodes arranged in a grid. From the differential equation of flow, a system of linear equations is derived and solved by computer. Unsteady flow conditions are approximated by solving the system for discrete steps in time, from commencement of pumping up to equilibrium. Model parameters, consisting of nodal values of transmissibility, leakance, and storage coefficient, are established by simulation of an actual period of pumping, for which the regional response is determined from readings at observation wells. The model can be used to solve many problems relating to aquifer response in an area. — *from* Author's abstract

03012 **Fritz, Madeleine A.** Redescription of type specimens of the bryozoan *Hallopora* from the Upper Ordovician of Toronto region, Ontario: Geol. Assoc. Canada Proc., v. 21, p. 15-23, illus., table, 1970.

The type specimens of *Hallopora*, originally described by Parks and Dyer from the Upper Ordovician of Toronto and vicinity are redescribed and refigured. — Author's abstract

02747 **Frondel, Clifford.** Early mineral collections in New England: Mineralog. Rec., v. 1, no. 1, p. 6-10, illus., 1970.

First known collections of minerals and ores in New England were those of John Winthrop the Younger, 1606-1676, and of his grandson, John Winthrop, Jr., 1681-1747, who presented the Royal Society with a collection of more than 600 specimens. The interest in minerals from Colonial through Revolutionary times in New England was practical; college instruction in mineralogy and related subjects began in the decades after 1800. Noteworthy 19th century collections were those of Col. George Gibbs, Parker Cleaveland, Archibald Bruce, Adam Seybert, and Amherst College; the last named included meteorites. The oldest continuously maintained collection in the United States is that at Harvard. The main period of development of American mineral collections was between the end of the Civil War and the first decade or so of the 20th century. Contributions of innumerable amateur collectors are acknowledged. — ESL

02505 **Furman, Marvin J.; Karner, Frank R.** Description of authigenic analcite in the Golden Valley Formation(?), southwestern North Dakota [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 11, 1970.

02276 **Futrell, Darryl.** Some notes on tektites: Gems and Minerals, no. 394, p. 22-25, 44-46, illus., reprinted 1970; originally published 1967.

This was first published in Sky and Telescope, v. 33, no. 5, p. 272-275, 1967. *See* Abstracts of North American Geology for August 1968. — MCM

02817 **Gaffney, Edward S.; Ahrens, Thomas J.** Stability of mantle minerals from lattice calculations and shock wave data, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 205-212, illus., tables, 1970.

Shock wave and static high pressure data for mantle minerals have indicated that at high pressures a series of denser polymorphs form whose crystal structures can at present only be inferred from calculated densities and crystal chemical arguments. To determine admissibility of some of these proposed structures theoretical Madelung lattice energies are calculated for several oxides and perovskites. Comparison of calculated enthalpies of formation with measured values yield approximate values for effects of covalency on enthalpies of formation for Al-O_6, Ti-O_6, SiO_4, Si-O_6, Fe^{3+}-O_6, Cr^{3+}-O_6, Fe^{3+}-O_4, and Fe^{2+}-O_4. This effect is very similar for the same ion pair in the same coordination but in different compounds. Calculations indicate that enstatite cannot enter a perovskite with a density greater than about 3.9 g/cm^3 and that the high pressure phase of Fe_2O_3 can be a perovskite only if the Fe^{3+} disproportionates into Fe^{2+} and Fe^{4+} and the 3d electrons in the latter are spin paired. — *from* Authors' abstract

Gagnon, P. M. *See* Fitzgerald, J. D. 02617

02833 **Gallimore, Robert G., Jr.; Lettau, Heinz H.** Topographic influence on tornado tracks and frequencies in Wisconsin and Arkansas: Wisconsin Acad. Sci., Arts and Letters Trans. 1970, v. 58, p. 101-127, illus., tables, 1970.

"Alleys" of high tornado frequency and "shunted" belts of low frequency were studied in Arkansas and Wisconsin to find possible relationships between tornado frequency and topography as well as the thermal structure of the earth/air interface. Terrane profiles were obtained by plotting elevations along these strips and spectral analyses made of height data. Results of the quantitative approach suggest that the terrane in tornado alleys is smoother and that tornadoes shy away from rough terrane. Surface temperatures were also plotted along the profiles and spectral analyses performed. Variations in many factors governing thermal response made it difficult to specify tornado-suppressing and tornado-supporting trends. Features of the land surface less than about 600 m high appear to have little significance for surface temperature variations. — EH

02548 **Gamble, E. E.; Daniels, R. B.; Nettleton, W. D.** Geomorphic surfaces and soils in the Black Creek Valley, Johnston County, North Carolina: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 276-281, illus., 1970.

Soils, 2-4 m thick, with plinthite in the middle B horizon are found on a geomorphic surface of early Pliocene age. This surface occupies the high narrow interstream divides of the upper Coastal Plain. These soils, classed as Paleudults, are formed in a relatively uniform sediment and have predictable profile characteristics. Soils less than 1.25 m thick, without plinthite, and classed as Hapludults are found on the valley-side slopes of Pleistocene to Recent age. Variations in the outcropping sediments and valley-side alluvium produce soils that are best mapped as complexes. — Soil brief

02577 **Gamble, E. E.; Daniels, R. B.; McCracken, R. J.** A2 horizons of Coastal Plain soils, pedogenic or geologic origin: Southeastern Geology, v. 11, no. 3, p. 137-152, illus., tables, 1970.

Many lines of evidence indicate that the A2 horizon of soils in the North Carolina Coastal Plain is of pedogenic origin. Those demonstrating a pedogenic origin are the uniformity of sand sizes across the A2-B horizon contact, the micro-intertongued A2-B horizon contact, near absence of oriented clay in the A2 and its abundance in the subjacent B2, eluvial-illuvial nature of the clay bands in the A2 horizon, the thickening and thinning and changes in color and clay content of the A2 in response to changes in soil drainage, and the presence of A2 horizons in soils on eolian sands. Any one of these would not be enough to negate the hypothesis that the A2 horizons are a separate geologic deposit, but when considered as a group they are very strong evidence for a pedogenic origin for the A2 horizons or surface sands. — Authors' abstract

Gardner, W. R. *See* Hillel, D. 02858

Garland, G. D. *See* Mabey, D. 02941

02397 **Garlick, G. D.; Dymond, J. R.** Oxygen isotope exchange between volcanic materials and ocean water: Geol. Soc. America Bull., v. 81, no. 7, p. 2137-2141, illus., tables, 1970.

The δO^{18} values of siliceous volcanic glass shards in deep-sea sediments increase with age, from +9 per mil in the Pleistocene to +20 per mil in the upper Eocene. Basaltic rocks also undergo isotopic alteration in the marine environment and exhibit a correlation between O-18:O-16 ratios and water contents. — Authors' abstract

Garrels, Robert M. *See* Mackenzie, Fred T. 02649

02619 **Garrett, Peter.** Deposit feeders limit development of stromatolites [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 848, 1970.

Garrett, Peter. *See* Smith, Donald L. 02684

02793 **Garrett, Peter.** Phanerozoic stromatolites, noncompetitive ecologic restriction by grazing and burrowing animals: Science, v. 169, no. 3941, p. 171-173, illus., table, 1970.

The abundance of stromatolites (algal laminated sedimentary structures) in the Precambrian followed by a decline in the Phanerozoic is explained by the evolution and diversification during the Phanerozoic of grazing animals which feed on surface algal mats and of burrowing animals which destroy sedimentary laminations. — Author's abstract

Gast, Paul W. *See* Sayyah, Taha. 02282

02819 **Gast, Paul W.** Dispersed elements in oceanic volcanic rocks [abs.], *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 246, 1970.

Gastil, R. G. *See* Peterson, G. L. 02995

02845 **Gawareckl, Stephen J.** Infrared survey of the Pisgah Crater area, San Bernardino County, California — A geologic interpretation, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 10-1 — 10-38, illus., table [1970].

Infrared imagery in the 8μ to 14μ band of the Pisgah Crater area, California, provided geologic information which complements data from ground studies and aerial photography. Thermal contrasts representative of those found through the diurnal cycle were acquired during 3 of 6 flight periods. The largest amount of information on geologic thermal parameters was obtained from imagery flown shortly after sunset. Among geologic features shown on imagery of one or more flight periods were basalt flow contacts where adjacent flows differed in surface character, distribution of pyroclastics and their alluvial derivatives on the flows, collapsed lava tubes, fissured areas, detail of the Pisgah fault, zonation within Lavic Dry Lake, active drainage on an alluvial fan, and moist areas suggestive of ground-water conditions. Infrared imagery proved to be superior to other remote-sensing systems in distinguishing such features. — *from* Author's abstract

02434 **Gay, S. Parker, Jr.** Some applications of geophysics to ground water exploration [abs.]: Mining Eng., v. 22, no. 1, p. 44, 1970.

Gelpi, E. *See* Levy, Ram L. 02737

02829 **Geol. Soc. America, Rocky Mtn. Sec.; Gries, J. P.** (editor). Guidebook and road logs for 23d Ann. Mtg., Rapid City, S. Dak., 1970: Rapid City, S. Dak., South Dakota School Mines and Technology, Dept. Geology and Geol. Eng., 36 p., illus., 1970.

This volume is a guidebook for the field trip of the 23d annual meeting of the Rocky Mountain section of the Geological Society of America. The meeting, sponsored by the South Dakota School of Mines and Technology, was held in Rapid City, May 6 to 9, 1970. Road logs for six trips, held in the Rapid City, Black Hills, and Big Badlands areas, are included, as well as a paper on the Homestake Mine which is cited separately. Field trips covered stratigraphy, engineering geology, metasediments, and pegmatites. — EH

02798 **Geol. Soc. America So.-Central Sec.; Berg, Robert R.** (editor). Outcrops of the Claiborne Group in the Brazos Valley, southeast Texas — Guidebook, 4th Ann. Mtg., 1970: [College Station, Tex.] Texas A and M Univ., Dept. Geology, 79 p., illus., 1970.

This guidebook for field trips of the 4th annual meeting of the South-Central Section of the Geological Society of America, held at College Station, Tex., from April 2-4, 1970, was compiled by the faculty and students of the Department of Geology, Texas A and M University, to describe details of selected parts of the Claiborne Group in the Brazos Valley, southeastern Texas. Four papers on the structure, stratigraphy, depositional environment, and paleoecology of the group are cited separately in this volume. Road logs to 13 localities and a description and section for each are included as well as a selected bibliography of the Claiborne Group. — EH

02525 **Gerken, A. N.** Depositional environment of the upper member of the Niobrara Chalk in northeastern Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 33-34, 1970.

02405 **Geyer, Alan R.; Shirk, William R.** Pennsylvania's secondary school earth science course, ten years of progress: Jour. Geol. Education, v. 18, no. 3, p. 118-121, illus., tables, 1970.

In Pennsylvania earth science is now taught in most secondary schools. Problems of teacher training, curriculum materials, and program implementation which existed in 1958 are compared with those of the present. A summary of answers of 400 earth science teachers to a questionnaire sent out in 1968 is given. Educational background and teaching experience are analyzed, and recommendations from the teachers are listed. — EH

02757 **Gibson, J. Sullivan; Batten, James W.** Soils, their nature, classes, distribution, uses, and care: University, Ala., Univ. Alabama Press, 296 p., illus., tables, 1970.

02518 **Gibson, Shirley.** (compiler). Cardiff Township, Haliburton County (data series): Ontario Dept. Mines Prelim. Geol. Map P. 603, scale 1 in. to 1/2 mi., text, 1970.

The main map on the sheet is an index to reports in the Resident Geologist's files; geologic and aeromagnetic sketch maps are inset. Cardiff Township is underlain by Grenville metasediments intruded and replaced by mafic and felsic plutonic rocks. Erosion reduced the area to a peneplain after the last Precambrian mountain building; thin Pleistocene glacial deposits cover much of the bedrock. Limited production of graphite, molybdenum, and fluorite began in 1910; uranium was first discovered in 1922, and since 1953 the area has become a center of major prospecting activity. — MCM

Gilbert, J. *See* Levy, Ram L. 02737

02567 **Giles, Leland H.** Soils of the Rio Grande Valley border in southern New Mexico: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 465-472, illus., table, 1970.

Torripsamments, Torriorthents, Camborthids, Haplargids, Paleargids, Calciorthids, and Paleorthids occur along the border of the Rio Grande Valley. Soil morphology and distribution are related to soil age, texture of parent materials, present and past climate, soil biota, geomorphic surface, and degree of landscape stability. Illuviation of carbonate in nearly all soils and illuviation of silicate clay in some soils are some of the present features of pedogenesis in this desert region. — Soil brief

02620 **Gill, Dan; Briggs, Louis I.** Silurian reef in Michigan basin, stratigraphic-, facies-, and reservoir-properties analysis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 848-849, 1970.

02307 **Gillott, J. E.** Fabric of Leda clay investigated by optical, electron-optical, and X-ray diffraction methods: Eng. Geology, v. 4, no. 2, p. 133-153, illus., tables, 1970.

Fabric, paleosalinity, and engineering data are given for five samples of Leda clay. It is shown that the layer structure silicates in two samples are oriented parallel to bedding, and that in the other three samples platy minerals have a near random arrangement. X-ray diffraction studies show that there is no difference in orientation of 7A and 10A layer structure silicates. Paleosalinity values deduced from boron content indicate that three of the samples were deposited in water fresher than normal marine, and the other two in a nearly normal marine environment. Correlation between fabric and paleosalinity data is fairly good. Moisture removal shows that original fabric can be affected by the technique of sample preparation. Evidence indicates that fabric was more affected by conditions at time of deposition than by subsequent events. — *from* Author's abstract

Gilmore, James C. *See* Antoine, John W. 02540

Girdley, W. Arch. *See* Baars, D. L. 02584

02621 **Glover, E. D.** Technique of observation of organized organic remains in carbonates [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 849, 1970.

Goldsmith, W. *See* Ricketts, T. E. 02403

02328 **Gordon, Donald C., Jr.** Some studies on the distribution and composition of particulate organic carbon in the North Atlantic Ocean: Deep-Sea Research, v. 17, no. 2, p. 233-243, illus., tables, 1970.

Samples from 50 stations in the North Atlantic were analyzed for particulate organic carbon. In many instances, concentrations varied significantly with respect to geographic location and depth. Striking temporal variations were observed in the deep waters of the Sargasso Sea. Fractionation studies were inconclusive and suggested that 1.2μ filters retained the greatest quantity of particulate matter. Hydrolysis ex-

periments using alpha-amylase, trypsin, and chymotrypsin demonstrated that at least 20 percent of the particulate organic carbon in deep water can be easily hydrolyzed. This hydrolyzable material is mostly nonliving and could constitute an important food source for bathypelagic organisms. Carbon and nitrogen ratios ranged from 7.8 to 15.5 —*from* Author's abstract

02370 **Gordon, W. A.** Biogeography of Jurassic Foraminifera: Geol. Soc. America Bull., v. 81, no. 6, p. 1689-1703, illus., tables, 1970.

The known Jurassic foraminiferal faunas of the world are classified into five broad types of assemblage rather than into conventional faunal realms. Three of the kinds of assemblage are typical of shelf regions, including the western interior region of North America, the northern two-thirds of Europe, and scattered points south of the Tethyan Zone. They are characterized respectively by simple arenaceous Foraminifera including reophacids, simple lituolids, and textulariids; nodosariids, and certain calcareous forms including epistominids, buliminids, or ophthalmidiids. The other two kinds of assemblage are typical of the Tethys seaway and are characterized by either planktonic foraminifera or arenaceous forms including pavonitids and discocyclinids. — *from* Author's abstract

02700 **Goreau, Thomas F.** Forereef slope ecology and depositional processes in Jamaica [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 849, 1970.

Gorham, Eville. *See* Sanger, Jon E. 02444

02451 **Grant, Douglas R.** Surficial deposits, geomorphic features, and late Quaternary history of the terminus of the Northern Peninsula of Newfoundland and adjacent Quebec-Labrador: Maritime Sediments, v. 5, no. 3, p. 123-125, illus., 1969 [1970].

A 20-mi long end-moraine system; minor moraines, best seen in lakes; low attenuated drumlinoids; and a few strandlines, raised up to 500 feet in Quebec-Labrador, are found in this area. Bedrock structure has distinctive geomorphic features: broad, curving swells on bevelled edges of gently folded beds, progressively disturbed eastward; narrow fracture depressions, usually in parallel systems; major N-S and E-W dislocations. Glacial scouring parallels joints, and there are some unroofed large solution cavities. A four-phase Wisconsin glaciation is indicated: advance of Laurentide ice from Labrador over Northern Peninsula lowlands, to perhaps 1,000 feet up flanks of Long Range Mts.; a 300-yr retreat; Long Range ice lobe readvance, with western lobe dated at 10,900 yr B.P.; and retreat with active ice flow. Many old cirques not reoccupied by later ice may indicate pre-Wisconsin glaciation. — GDC

02452 **Grant, Douglas R.** Late Pleistocene re-advance of piedmont glaciers in western Newfoundland: Maritime Sediments, v. 5, no. 3, p. 126-128, illus., 1969 [1970].

In the southern half of the Northern Peninsula, the Long Range ice expanded westward between nunataks as piedmont glaciers leaving interlobate and recessional moraines in late Wisconsin, 11,000 yr ago. Ice spreading from a 1,500-ft divide along the median line of the Long Range plateau moved eastward downslope; to the west it scoured bedrock in valleys, and bordered hilltop felsemeer with short morainal segments, swaths of stripped bedrock, and meltwater channels. The ice tongues spread out over the western lowland; their kettled and ridged moraines were truncated or subdued at postglacial marine limits. Inferred extensions of morainal segments and added marginal positions mark recession stages; spasmodic retreat of ice tongues is reflected in small changes in sea level; subordinate trimlines and succession of moraine-dammed lakes suggest lowering of the ice-field surface. — GDC

Grant, F. S. *See* West, G. F. 02958

Grayson, Michael A. *See* Levy, Ram L. 02737

02487 **Green, D. H.** Peridotite-gabbro complexes as keys to petrology of mid-oceanic ridges — Discussion [of paper by T. P. Thayer, 1969]: Geol. Soc. America Bull., v. 81, no. 7, p. 2161-2166, 1970.

Green comments that Thayer's (ibid., v. 80, p. 1515-1522, 1969) article is important in that it genetically relates ultramafic occurrences in the contrasted environments of oceanic rift systems and orogenic belts. However, he fails to recognize peridotites of high temperature type and absence of associated gabbros with some peridotites and thus fails to exploit the full possibilities of his theme. This note presents the concept of diapiric upwelling of pyrolite upper mantle. Processes of basaltic magmatism and peridotite emplacement are considered to be intimately related. There are variations in extent and conditions of melting of the parent peridotite and in extent to which peridotitic residues, basaltic liquids and basaltic accumulates become mechanically separated, and the differences account for the variety of ultramafic complexes present in both oceanic ridge and orogenic environments. — *from* Author's conclusions

03008 **Green, H. W., 2d; Radcliffe, S. V.; Heuer, A. H.** High voltage (800 kv) transmission electron microscopy study of a type III carbonaceous chondrite [abs.]: EOS, v. 51, no. 4, p. 341, 1970.

Green, S. J. *See* Friedman, M. 02401

02824 **Green, Trevor H.** High pressure experimental studies on the mineralogical constitution of the lower crust, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 441-450, illus., tables, 1970.

Diorite and gabbroic anorthosite have been proposed as two possible overall compositions for the lower crust; mineral assemblages stable in these compositions under anhydrous conditions at 900-1200°C and pressures to 36 kb have been determined. Low pressure mineralogy is dominated by plagioclase, with subordinate pyroxene and minor quartz; with increasing pressure garnet appears, and garnet, quartz and clinopyroxene form at the expense of plagioclase. At pressures > 20 kb at 900-1200°C plagioclase disappears and the assemblage is clinopyroxene + quartz (coesite) + garnet + K-feldspar ± kyanite(?). Extrapolating experimental results to P-T conditions predicted for a stable, anhydrous lower crust and calculation of compressional wave velocities for these compositions supports models of a diorite or gabbroic anorthosite lower crust, where mineralogy consists of clinopyroxene, sodic plagioclase and subordinate quartz, garnet. —*from* Author's abstract

Greene, Robert C. *See* Irwin, William P. 02334

Gries, J. P. *See* Geol. Soc. America, Rocky Mtn. Sec. 02829

02622 **Gries, Robbie Rice.** Biostratigraphy of Carboniferous rocks, San Saba County, central Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 849, 1970.

02526 **Griesemer, Allan D.; Rowell, Bruce F.** Semiquantitative biofacies analysis of shale samples [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 34, 1970.

02329 **Grill, E. V.** A mathematical model for the marine dissolved silicate cycle: Deep-Sea Research, v. 17, no. 2, p. 245-266, illus., tables, 1970.

An equation for vertical distribution of dissolved silicate is derived that is applicable to intermediate depth levels of ocean areas where horizontal transport is negligible. It is assumed that a steady state exists and that dissolved silicate concentrations are maintained by a balance between vertical mixing, vertical advection, and solution or synthesis of biogenous silica. Expressions are formulated for biologic assimilation of silicate at subsurface depth by radiolarians and for solution of silica from sinking diatoms and radiolarians. Silica solution is assumed to be largely controlled by physical and chemical phenomena associated with feeding activities of grazing organisms. Resulting distribution relations were in good agreement with observed vertical profiles of dissolved silicate in the Pacific and Atlantic above deep water. Constants evaluated by empirically fitting theoretical relations to observed distributions can be used to make valid predictions. —*from* Author's abstract

02877 **Grove, E. L.; Perkins, Alfred J.** (editors). Developments in applied spectroscopy, V. 7B — Mid-America Spectroscopy Symposium, 19th Ann., Chicago, Ill., 1968, Selected papers: New York and London, Plenum Press, 291 p., illus., tables, 1970.

Volume 7B includes 19 papers on physical-organic developments in applied spectroscopy presented at the 7th National Meeting of the Society of Applied Spectroscopy. Papers are grouped in sections on infrared and Raman spectroscopy, internal-reflection spectroscopy, nuclear magnetic resonance spectroscopy, and spectrochemical applications to textiles and fibers. Two papers are cited separately. — ESL

Guthrie, R. Dale. *See* Hoskin, Charles M. 02991

02623 **Gutschick, Raymond C.; Sandberg, Charles A.** Latest Devonian conchostracans along Cordilleran miogeosyncline, Alberta, Montana, Utah, and Nevada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 849-850, 1970.

02624 **Hadley, Donald G.** Paleocurrents and origin of Huronian Lorrain Formation, Ontario and Quebec [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 850, 1970.

02242 **Haggerty, S. E.; Lindsley, D. H.** Stability of the pseudobrookite (Fe_2TiO_5)-ferropseudobrookite ($FeTi_2O_5$) series: Carnegie Inst. Washington Year Book 68, 1968-69, p. 247-249, illus., 1970.

02243 **Haggerty, S. E.** Magnetic minerals in pelagic sediments: Carnegie Inst. Washington Year Book 68, 1968-69, p. 332-336, 1970.

02244 **Haggerty, S. E.** A new iron-phosphate mineral: Carnegie Inst. Washington Year Book 68, 1968-69, p. 330-332, table, 1970.

03006 **Haggerty, S. E.; Irving, E.** On the origin of the natural remanence (NMR) of the Mid-Atlantic Ridge at 45°N [abs.]: EOS, v. 51, no. 4, p. 273, 1970.

03007 **Haggerty, Stephen E.** Mid-Atlantic Ridge near 45°N, magnetic mineralogy [abs.]: EOS, v. 51, no. 4, p. 273, 1970.

02924 **Hallof, Philip G.** The use of induced polarization measurements to locate massive sulphide mineralization in environments in which EM methods fail [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 302-309, illus., 1970.

For many years the EM method, used worldwide in the search for massive sulfide mineralization, has been useful in environments in which mineralization is at shallow depth. Recent experience has shown that some zones of 'massive' sulfide mineralization are not EM conductors, in some cases due to type and/or concentration of mineralization in the zone, or because of depth to top of the source; in other situations the geologic environment is such that EM anomalies from sulfide mineralization cannot be distinguished from those due to ionic conductors. The IP method has been found more useful than EM techniques in these situations. Results are available from areas where source is at considerable depth, as well as areas of ultrabasic rocks and semiarid and tropic weathering in which numerous ionic conductors are present. — *from* Author's abstract

02544 **Hannah, Peter R.; Zahner, Robert.** Nonpedogenetic texture bands in outwash sands of Michigan — Their origin, and influence on tree growth: Soil Sci. Soc. America Proc., v. 34, no. 1, p. 134-136, illus., tables, 1970.

Origin of many thick well-developed nonpedogenetic texture bands is attributed to deposition in glacial outwash concurrent with the deposition of adjoining layers of sand outwash. Nonpedogenetic bands are thicker, less stratified, finer textured, and more massive and convoluted than pedogenetic bands. Roots of forest trees tend to branch and proliferate in the region immediately above thin bands and penetrate and

develop normally in thick till-like bands. Site indexes for natural jack pine (*Pinus banksiana* Lamb.) and bigtooth aspen (*Populus grandidentata* Michx.) stands, and stemwood production in red pine (*Pinus resinosa* Ait.) plantations are significantly higher on soils with prominent texture bands than on soils where bands are absent or weakly developed. — Authors' abstract

02950 **Hansen, Don A.** Iron ore exploration in North and South America [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 371-380, illus., tables, 1970.

The application of geophysics to iron ore exploration may be direct or indirect. Both modes of application depend upon the existence of a measurable physical property contrast directly or indirectly associated with the iron ore. Because magnetite is almost unique among ore minerals in its property of magnetic polarization, magnetic surveying is the geophysical method most widely applied in iron ore exploration. Theoretical curves and field examples illustrate the variation in magnetic response as a function of latitude in North and South America. — Author's abstract

02762 **Hapgood, Charles H.** The path of the pole (revised edition of *Earth's shifting crust*): Philadelphia, Pa., and New York, Chilton Book Co., 413 p., illus., tables, 1970; originally published 1958.

Hare, P. E. *See* Abelson, P. H. 02225

Harms, J. C. *See* Walker, Roger G. 02695

02625 **Harper, J. D.** Trends of faunal morphologic variation and their environmental significance, key to paleoecologic analysis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 850, 1970.

02626 **Harris, D. G.; Young, A.; Hay-Roe, H.** Formation pressure patterns in Cretaceous Viking Formation, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 850-851, 1970.

02787 **Harris, Sherod A.** Bends of the South Canadian River of Oklahoma as related to regional geomorphology: Shale Shaker, v. 20, no. 5, p. 80-95, illus., 1970.

Three pronounced bends on the South Canadian River, in Dewey County and between Ellis and Roger Mills Counties, have been given shallow and deep structural connotations, even related to deep-seated faulting. However, Harris believes their origin is better explained by geomorphology. The major factor is contrast in strikes of unconformable strata in the Anadarko Basin, outcropping across the regional surface slope. As the Tertiary cover is removed, streams work north up the Permian, and south along Cretaceous-Triassic or Tertiary outcrops; piracy of adjacent drainages without bends of this type results — the Washita River will most likely capture South Canadian drainage. No structural connotation beyond that connected to regional tilt can be assumed for either the development of bends or stream piracy. — GDC

02791 **Harrison, J. C.; Longley, W. W.** Denver earthquakes: Science, v. 169, no. 3941, p. 211, 1970.

Observations since 1965 at the seismograph station at Boulder, Colo., 40 km W-NW of Rocky Mountain Arsenal well, show that events at Derby of magnitude 1.5 on Major and Simon's listings (1968) can often be detected at Boulder but would not be distinguished from background in absence of these listings. Events of magnitude 1.8 usually stand out well, and those of 2.0 or greater give clear traces. A systematic search through records from April 1954 to November 1959 failed to reveal a single event with characteristics of modern Derby earthquakes. Events thought to be such by Krivoy and Lane (1966) have been identified as artificial explosions. The average frequency of Derby of $M > 2.0$ was about four per month between 1962 and 1968. It is concluded that earthquake activity at the Arsenal during the 1950's, if any, was nearly two orders of magnitude less than during and immediately after the pumping of the disposal well. — DBV

Hart, S. E. *See* Krogh, T. E. 02248

Hart, W. *See* Bogard, D. D. 02270

Harward, M. E. *See* Carstea, D. D. 02569

02367 **Hashad, A. H.; Damon, Paul; Whelan, J. A.** Precambrian geochronology of the central Wasatch Mountains, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 15-17, tables, 1970.

The central Wasatch Mountains between Ogden and Salt Lake City have had a complex geologic history; figuring prominently are Precambrian metamorphism and Tertiary intrusion. Oldest rocks are the Farmington Canyon complex (Middle Precambrian), followed by the Little Willow Series. K-Ar age determinations on rocks of the Farmington Canyon complex range from 224 m.y. on biotite in migmatite to 1,700 m.y. on hornblende in gneiss; of the Little Willow Series from 19 ± 10 m.y. on muscovite in schist to 560 m.y. on hornblende in amphibolite; a Pb-α age on zircon from quartz monzonite gave 34.5 m.y. The earliest determinable metamorphic event in the Precambrian of the area occurred about 1,600 m.y. ago and a thermal event, accompanied by intrusion, about 550 m.y. ago. — MCM

02627 **Haun, John D.; Barlow, James A., Jr.** Lower Tertiary deltas and petroleum, Rocky Mountain region [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 851, 1970.

02456 **Hawaii Div. Water and Land Devel.** An inventory of basic water resources data, Island of Hawaii: Hawaii Div. Water and Land Devel. Rept. R34, 188 p., illus., tables, 1970.

The five hydrographic areas of the island of Hawaii are the major drainage basins. Climatology and general water supply of the island are outlined. Ground water, which occurs as basal water floating on salt water, dike-confined water, water perched on relatively impervious soil or rock formations, and shallow ground water, is delineated for the hydrographic areas. Springs are most prevalent on the windward side of the island. Tabulated data include indexes for drilled test holes, drilled wells, dug wells and water holes, shafts, tunnels, and springs; and records for wells, shaft pumpage, tunnel discharge, spring flow, and water quality. — MCM

Hawkes, Herbert E. *See* Bloom, Harold. 02435

02628 **Hayes, Miles O.; Boothroyd, Jon C.; Hine, Albert C., 3d.** Diagnostic primary structures of estuarine sand bodies [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 851, 1970.

Hay-Roe, H. *See* Harris, D. G. 02626

02527 **Heald, Sally Lynne.** Slope orientation and modification of the Holmes Lake watershed, Lancaster County, Nebraska: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 34, 1970.

02792 **Healy, J. H.; Marshall, P. Anthony.** Nuclear explosions and distant earthquakes, a search for correlations: Science, v. 169, no. 3941, p. 176-177, illus., tables, 1970.

An apparent correlation between nuclear explosions and earthquakes has been reported for the events between September 1961 and September 1966. When data from the events between September 1966 and December 1968 are examined, this correlation disappears. No relationship between the size of the nuclear explosions and the number of distant earthquakes is apparent in the data. — Authors' abstract

02342 **Heard, Nancy.** Jack Frost (1900-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1308, portrait, 1970.

02629 **Heckel, Philip H.** Organic carbonate buildups in epeiric seas, some theoretical aspects [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 851-852, 1970.

02464 **Heigold, Paul C.** A gravity survey of extreme southeastern Illinois: Illinois Geol. Survey Circ. 450, 12 p., illus., 1970.

The Illinois State Geological Survey is currently engaged in a program to cover the entire state of Illinois with a gravity survey having approximately one mile grid spacing. Several reports concerned with portions of this state-wide survey have already been published. Included in this report is a simple Bouguer gravity anomaly map of extreme southeastern Illinois which includes the southeastern extremities of the Fairfield Basin and fluorspar district of southern Illinois. This area possesses, perhaps, the most complex array of geologic structures to be found in Illinois. The gravity anomalies of extreme southeastern Illinois appear to be related to deep-seated basic intrusives and near-surface lateral density contrasts. — Author's abstract

02852 **Hemphill, William R.** Application of ultraviolet reflectance and stimulated luminescence to the remote detection of natural materials, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 19-1 — 19-2, illus. [1970].

Tests, using a cathode-ray-tube transmitter, an image-dissector receiver and a video monitor, showed the feasibility of imaging ultraviolet-stimulated luminescence of minerals which exhibit relatively high reflectance in the ultraviolet region (< 3600 angstroms), such as talc, dolomite and deweylite, along quarry faces from distances of several hundred feet. In the laboratory a pulsed ultraviolet laser emitting at 3371 angstroms stimulated phosphorescence of rock and mineral specimens and discriminated between them on the basis of decay time. The "Fraunhofer line-depth method," which uses the sun as an ultraviolet source, and a high-resolution grating spectrometer were used to detect luminescent materials. A Fraunhofer line-discriminator suitable for aircraft operation has been constructed and initial tests on Rhodamine WT are being performed. — *from* Author's abstract

02422 **Henkel, D. J.** The role of waves in causing submarine landslides [with French abs.]: Géotechnique, v. 20, no. 1, p. 75-80, illus., 1970.

The effects of ocean waves on the stability of underwater slopes in soft underconsolidated deltaic sediments are examined. The pressure changes on the sea floor, associated with the passage of a wave, are able to cause shear failure in soft sediments in water depths up to about 400 feet. [The Mississippi Delta is an example.] The waves impose an oscillatory motion on the soft sediments which, on sloping ground, leads to a mass transfer of soil down slope. Also the repeated reversals of shear strain in the sediment cause remolding of the sediment and a reduction of shear strength. — Author's abstract

02482 **Herdendorf, Charles E.** Sand and gravel resources of the Maumee River estuary, Toledo to Perrysburg, Ohio: Ohio Div. Geol. Survey Rept. Inv. 76, 19 p., illus., tables, 1970.

The Maumee-Toledo dredging corridor, between Toledo and Perrysburg, extends upstream from Maumee Bay on the lower Maumee River and covers an area of approximately 1.5 sq mi. This study maps the sand and gravel deposits in the corridor. Grain-size analyses of samples obtained from bottom profiling, sampling and test boring are given in a table. Midriver deposits adjacent to Delaware and Clark Islands yielded materials of the best grade for concrete sand. The best mortar and mason sand came from north of Burns Island. Good mix and cover sand was found throughout the area. Removal records of sand and gravel are given and reserves estimated at about 16 million cu yds, though this figure could be much higher. — EH

Herriman, R. C. *See* Parsons, R. B. 02955

Hertweck, Gunther. *See* Reineck, Hans-Erich. 02672

Heuer, A. H. *See* Green, H. W., 2d. 03008

02388 **Hickling, Nelson L.; Phair, George; Moore, Roosevelt; Rose, Harry J., Jr.** Boulder Creek Batholith, Colorado — Pt. 1, Allanite and its bearing upon age patterns: Geol. Soc. America Bull., v. 81, no. 7, p. 1973-1993, illus., tables, 1970.

Allanite is a late-replacement mineral in the comagmatic rocks of the Precambrian Boulder Creek Batholith, associated amphibolite xenoliths and related hybrid rocks, and distinctly younger intrusions of Silver Plume Granite that cuts these rocks. It develops by replacement of biotite, probably in the presence of emanations from rare earth- and thorium-rich Silver Plume Granite. Much of the allanite has been recrystallized, and some of the recrystallized allanite is replaced by epidote along the allanite-biotite borders. Birefringence is that expectable in allanite of Late Cretaceous to early Tertiary age. Detailed analytical, X-ray, and optical data are given for the allanite. — EHP

Higer, Aaron L. *See* Kolipinski, Milton C. 02906

High, Lee R., Jr. *See* Picard, M. Dane. 02703

02858 **Hillel, D.; Gardner, W. R.** Measurement of unsaturated conductivity and diffusivity by infiltration through an impeding layer: Soil Sci., v. 109, no. 3, p. 149-153, illus., 1970.

A method is described for measuring the hydraulic transmission properties of a soil column as a function of water content. It involves a series of infiltration trials through crusts of different hydraulic resistance. The resistance effect induces a suction at the surface of the column. An actual measurement of the capillary conductivity is obtained by allowing the process to proceed to the steady stage. — JWH

02528 **Hillerud, John M.** A subfossil assemblage from Milburn, Custer County, Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 34-35, 1970.

Hillis, S. F. *See* Skermer, N. A. 02893

Hills, L. V. *See* Shepheard, W. W. 02295

Hine, Albert C., 3d. *See* Hayes, Miles O. 02628

02529 **Hingorani, G. G.** The role of computers in geophysics and its relationship to exploration [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 35, 1970.

02630 **Hitchon, Brian; Billings, Gale K.; Klovan, J. E.** Factors controlling chemical composition of formation waters, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 852, 1970.

02919 **Hobson, George D.** Seismic methods in mining and groundwater exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 148-176, illus., table, 1970.

Seismic methods have not been exploited extensively as an exploration device for minerals and water; however, many oil prospecting seismic techniques and equipment can be applied with minor adaptation to these problems. Compact portable seismographs now available are used in the refraction mode while there are a few that can record reflected events; most can be used with a hammer struck against a steel plate on the ground as a source of energy. Various types of repetitive sources of energy used in oil prospecting could also be used in mineral prospecting. The various portable seismographs and their special adaptabilities or features, repetitive sources for land and marine seismic programs and some field techniques are presented. Some applications of shallow seismic techniques are set forth with some typical field results from minerals and water search projects. — *from* Author's abstract

02245 **Hoering, T. C.** Optically active steranes in a Miocene petroleum: Carnegie Inst. Washington Year Book 68, 1968-69, p. 303-307, illus., 1970.

02396 **Hoffer, Jerry M.** Petrology and mineralogy of the Campus Andesite pluton, El Paso, Texas: Geol. Soc. America Bull., v. 81, no. 7, p. 2129-2135, illus., table, 1970.

The Campus Andesite represents a small pluton in the Rio Grande valley and crops out on the campus of the University of Texas at El Paso. The mass is post-Cretaceous,

showing intrusive contacts with shale and marl of the Boquillas Formation and is surrounded by Quaternary lake or alluvial deposits. The age, based on a K-Ar date, is 47.1 ± 2.3 m.y. The intrusive is porphyritic with phenocrysts averaging 2 to 3 mm in length and set in an aphanitic groundmass. The phenocrysts, composed dominantly of andesine comprise about 40 percent of the rock. The mineralogy of the andesite consists of phenocrysts of plagioclase, biotite, and hornblende in a groundmass of plagioclase, K-feldspar, and minor quartz and magnetite. Chemical analyses indicate a composition between an andesite and a dacite. The rock is classified as a porphyritic andesite. — *from* Author's abstract

Hoffman, Barry L. P. *See* Hoskin, Charles M. 02991

Holden, John C. *See* Dietz, Robert S. 02490

Hollister, J. C. *See* Mabey, D. 02941

02346 **Hollister, Victor F.** Edward H. Wisser (1895-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1311-1312, portrait, 1970.

02908 **Hollyday, Este F.** Use of infrared imagery to locate surficial aquifers, Delmarva Peninsula, Maryland and Delaware, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 25-1 — 25-14, illus. [1970].

Infrared imagery was tested as a rapid reconnaissance technique for locating the thickest sections of water-bearing surficial sand on the Delmarva Peninsula. Imagery was obtained from NASA aircraft overflights in July 1967 and January 1968. The location of the three strongest and most diffuse thermal anomalies seemed to be controlled by these hydrogeologic constraints: areas of thick surficial sands, short reaches of major streams almost immediately above the head of estuaries, and absence of fine-grained marine sediments overlying surficial sand aquifers. Infrared imagery can be used to locate thick surficial sand aquifers only where all the hydrogeologic constraints are satisfied, and also to locate major modes on the discharge boundary of regional ground-water flow systems. — *from* Author's abstract

02951 **Hood, Peter.** Magnetic surveying instrumentation — A review of recent advances [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 3-31, illus., tables, 1970.

The four basically different airborne magnetometers in field use are: fluxgate, proton precession, aspect-tube, and optical absorption magnetometers; the latter has a sensitivity nearly two orders of magnitude better than the fluxgate type. Successful development of these higher-resolution instruments has produced a renaissance in the magnetic prospecting method. Transistorized compact low-power consumption electronic ground magnetometers have now replaced almost completely the magnetic-balance type. Study of magnetic properties of rock formations to account for observed anomalies is also receiving increased attention. Both susceptibility and remanent magnetization of a given rock formation should be measured; instruments for this purpose are commercially available. — *from* Author's abstract

02631 **Hopkins, John P.; Mountjoy, Eric W.** Reef-margin and basin sedimentation, Miette reef complex, Jasper National Park, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 852, 1970.

Hopper, Margaret G. *See* Bollinger, G. A. 02305

02716 **Hornberger, George M.; Ebert, Janet; Remson, Irwin.** Numerical solution of the Boussinesq equation for aquifer-stream interaction: Water Resources Research, v. 6, no. 2, p. 601-608, illus., 1970.

An efficient numerical technique is used to obtain solutions of the Boussinesq equation for problems of groundwater recession and groundwater flow in response to changes in stream stage. Comparison of the numerical results with the analytical

solution of *Boussinesq* [1904] attests to the accuracy of the former. The solution of a recession problem indicates that the form of the *Werner and Sundquist* [1951] model of groundwater discharge recession is appropriate. The solution of a problem involving changing boundary conditions on an aquifer because of a flood wave provides data relative to groundwater outflow. A comparison with the results of *Cooper and Rorabaugh* [1963] evaluates the applicability of a linear model of unconfined flow. — Authors' abstract

02408 **Horne, Gregory S.** Complex volcanic-sedimentary patterns in the Magog Belt of northeastern Newfoundland: Geol. Soc. America Bull., v. 81, no. 6, p. 1767-1788, illus., table, geol. map, 1970.

Lower Paleozoic strata are well exposed at the northern end of the Appalachian volcanic belt. The region has been segmented by major faults into structural-stratigraphic blocks which reflect differing sedimentary and tectonic histories. The rocks compose an eugeosynclinal assemblage over 2300 m thick ranging in age from earliest Ordovician through early Silurian. The typical succession represents a coarsening flysch pattern of deposition. Early deposits interfinger with mafic lavas and are richly volcanogenic. Later strata represent increasing introduction of felsic detritus. Latest deposits are quite coarse clastics, representing cannibalization of earlier deposits and the influx of volcanic debris. The region has a tectonic history probably analogous with other parts of the Appalachian orogenic belt and supports recent hypotheses on global tectonics and sea-floor spreading. — *from* Author's abstract

02632 **Horvitz, Leo.** Geochemical prospecting for petroleum [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 852-853, 1970.

02991 **Hoskin, Charles M.; Guthrie, R. Dale; Hoffman, Barry L. P.** Pleistocene, Holocene and recent bird gastroliths from interior Alaska [with French and Russian abs.]: Arctic, v. 23, no. 1, p. 14-23, illus., 1970.

Polished and rounded grains of quartz, secondary quartz and chert have been found in loess and peat in interior Alaska. The intermediate diameter of these grains is between 35 and 0.07 mm, with grains of 0.7 mm, 2 to 4 mm, and perhaps 10 to 20 mm being most abundant. Polish has been produced by abrasion in bird gizzards. Gizzard-bearing birds live in interior Alaska today and produce glossy polish on their gastroliths comparable to the polish on those from Holocene and Pleistocene deposits. The polish and roundness of recent bird gastroliths vary, being more pronounced in those of living birds in late winter. Some Holocene and Pleistocene polished gastroliths may have been produced by species of birds not now living in Alaska, as modal size classes of the ancient gastroliths do not coincide with classes of polished gastroliths from birds living there now. — *from* Author's abstract

02752 **Hotchkiss, Frederick H. C.** North American Ordovician Ophiuroidea — The genus *Taeniaster* Billings, 1858 (Protasteridae): Biol. Soc. Washington Proc., v. 83, no. 5, p. 59-75, 1970.

From study of type material of all North American Ordovician species of Protasteridae, a new generic diagnosis for *Taenaster* Billings, 1858, and new description and synonymy for the genotype, *T. spinosus* (Billings), are presented. Billings based the genus on three syntypes of *Palaeocoma spinosa*; the unfigured one (aboral view), on which Spencer (1934) based his generic diagnosis, is found to belong to a different genus from the two figured syntypes (oral views); thus, the diagnosis by Spencer and Wright (1966) in the Treatise on Invertebrate Paleontology cannot stand. Billings's first figured syntype is here selected as the lectotype of *T. spinosus*; three other species of the genus and two species of *Protaster* are placed in synonymy. The unfigured syntype and other specimens are placed in *Protasterina*. *T. spinosus* is recorded from the Trentonian to Richmondian of eastern North America. — VMJ

02302 **House, Eldon.** Wyoming stratigraphic correlation chart: Earth Sci. Bull., v. 3, no. 1, p. 14, 1970.

The Wyoming stratigraphic nomenclature chart, revised by the Stratigraphic Nomenclature Committee of the Wyoming Geological Association in 1969, is presented here. It covers Precambrian through Tertiary units. — EH

02633 **Howard, James D.; Frey, Robert W.** Examination of Georgia coastal sediments with N.E.L. spade corer [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 853, 1970.

Howard, James D. *See* Reineck, Hans-Erich. 02672

02386 **Howard, James F.; Kissling, Don L.; Lineback, Jerry A.** Sedimentary facies and distribution of biota in Coupon Bight, lower Florida Keys: Geol. Soc. America Bull., v. 81, no. 7, p. 1929-1945, illus., 1970.

Coupon Bight, a shallow semienclosed 9-sq-km bay, has a complex environmental setting that affords an excellent opportunity to examine the interaction of physiochemical and biologic agents and the relation of these to sedimentation within a small area. High temperature and salinity variations result in a less diverse biota but more pronounced faunal variations than in the more homogenous Inner Reef Tract. Open bay, nearshore, restricted bay, baymouth bank, and tidal channel environments are present. Unconsolidated sediment is mainly autochthonous skeletal debris ranging from sand to mud. Most mud deposits are trapped on *Thalassia* covered mud banks. — *from* Authors' abstract

02634 **Howe, Herbert J.** Occurrence and significance of ribbing variations in Late Ordovician brachiopods [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 853, 1970.

Huff, D. M. *See* Deal, D. E. 02504

02446 **Hummel, F. A.; Auh, Keunho; Johnson, G. H.** Synthesis of the chromium analogue of (α) spodumene and its solubility relationships with ureyite and β-spodumene: Materials Research Bull., v. 5, no. 5, p. 301-306, illus., table, 1970.

$LiCrSi_2O_6$ and $NaCrSi_2O_6$ have been synthesized by dry reaction and found to be partially soluble in each other. At 1120°C, 40 mole percent $NaCrSi_2O_6$ is soluble in $LiCrSi_2O_6$, and about 20 mole percent $LiCrSi_2O_6$ is soluble in $NaCrSi_2O_6$. At atmospheric pressure over 15 mole percent, $LiAlSi_2O_6$ has been found to enter α- (chrome) spodumene at 1100°C, and about 10 mole percent $LiCrSi_2O_6$ is soluble in a β-spodumene at 1185°C. Exsolution of Cr^{3+} readily occurs from the β-spodumene structure at lower temperatures, and it has been found to be almost completely exsolved at 1000°C if held for a month. Data on the linear aggregate thermal expansion of α-(chrome) spodumene, ureyite, β-spodumene and their associated solid solutions were obtained. — Authors' abstract

Hurley, R. J. *See* Malloy, R. J. 02387

02712 **Hussain, M. S.** A study of minerals in some Hawaiian soil colloids: Pakistan Jour. Sci. and Indus. Research, v. 12, no. 3, p. 222-226, illus., 1970.

Minerals in the clay fraction of soils developed from basalt on the northern slope of Kawailoa Ridge, Oahu, were analyzed by X-ray diffraction. Most interesting is the distribution of illite and kaolinite in the soils — illite increases uphill with increase of rainfall, and kaolinite is more concentrated at lower elevations with decrease of rainfall. In the soil of maximum rainfall is considerable amorphous material, probably allophane, and in high zones also gibbsite. There is a slight increase of montmorillonitic minerals in the soils of lower elevations. It has been suggested that the illite formed during pedogenesis and the source of potassium was in the recycling of K^+ by native vegetation. It would seem that as rainfall increases, montmorillonite is replaced by kaolinite, and that in turn by gibbsite in a weathering process of desilication. — GDC

02713 **Hussain, M. S.** Extractable aluminium content in some Hawaiian soils: Pakistan Jour. Sci. and Indus. Research, v. 12, no. 3, p. 217-221, illus., table, 1970.

Extractable aluminum in 22 soil samples from a N-S transect on the northern slope of Kawailoa Ridge, Oahu, was determined with four different extracting solutions. All solutions extracted a higher amount of aluminum from subsoils than from surface soils. In soils where pH was low the extractable aluminum content was high with all but distilled water, and low where pH of the soil was below 6.0. Even with two solutions buffered at pH 4.8, the extractability of aluminum depended on original pH of the soils. There are positive correlations between extractable aluminum with KCl and $Ba(COOCH_3)_2$, and also between that with NH_4COOCH_3 and $Ba(COOCH_3)_2$ solutions. The amount of aluminum in the sugarcane sheaths ranged from 14 to 47 ppm. — *from* Author's abstract

Ichisugi, Norio. *See* Uchida, Kinsuke. 02474

02413 **Idriss, I. M.; Seed, H. Bolton.** Seismic response of soil deposits: Am. Soc. Civil Engineers Proc., v. 96, paper 7175, Jour. Soil Mechanics and Found. Div., no. SM2, p. 631-638, illus., 1970.

An analytical procedure for evaluating the seismic response of horizontal soil layers is presented, incorporating equivalent linear moduli and damping ratios varying with depth. The use of this procedure is illustrated [in San Francisco] and its results compared to recorded values and to computed values using a constant damping solution. These comparisons indicate that the variable damping solution often provides response values that are in better agreement with recorded values than those obtained from constant damping solution. The difference does not appear to be very great when the deposit consists of soils that have essentially similar characteristics. Much greater differences are obtained when the deposit consists of sublayers having greatly varying characteristics. — *from* ASCE abstract

02961 **Iida, Chuzo; Yamasaki, Kazuo.** Atomic absorption spectrometric analysis of silicates by the absorption tube technique: Anal. Letters, v. 3, no. 5, p. 251-257, tables, 1970.

By the combined use of the absorption tube technique and solvent extraction, determination of cadmium, cobalt, copper, iron, lead, and nickel in silicate rocks was investigated. Applicable concentration range was from 0.1 to 1.0 ppm for all the elements except cadmium, for which the range was from 0.005 to 0.025 ppm. The accuracy and recovery determined by the use of standard samples from the United States National Bureau of Standards and Geological Survey were satisfactory for practical purposes. — Authors' abstract

02923 **Innes, M. J. S.** A new gravity anomaly map of Canada — An aid to mineral exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 238-248, illus., 1970.

During the past decade the Dominion Observatory carried out systematic gravity surveys over approximately 2/3 of the land mass of Canada including portions of the continental shelves; reconnaissance gravity surveys were completed for large portions of the Northwest Territories, Hudson Bay, and western mountain areas. Data for 93,000 stations, including those of universities and industry, have been used to compile the new Bouguer gravity anomaly map at a scale of 1:2,500,000. Regional surveys provide fundamental information regarding nature, composition, and structure of the Earth's outer shell which may have a profound influence on future search for mineral deposits. Larger variations of the gravitational field are examined in this paper in relation to major structural elements. Particular attention is given to interpretation of anomalies for the Precambrian Shield. — *from* Author's abstract

02493 **Irish, E. J. W.** GSC leads way to new plays — History of Geological Survey of Canada in western Canada and Arctic islands: Oilweek, v. 21, no. 17, p. 35-38, illus., 1970.

The Geological Survey of Canada was formed in 1842 when Canada comprised only parts of present Ontario and Quebec. In 1867 the Survey's area became continent-wide in scope; in 1880 the Arctic Archipelago was included when Great Britain transferred that region to Canada. The history of geological exploration of western

Canada which began in 1869, the Canol Project in the Mackenzie River basin where oil was discovered in 1920, geologic exploration in the Arctic Archipelago, use of aircraft, geophysical offshore mapping, modern geological investigations, and the functions of the Institute of Sedimentary and Petroleum Geology are summarized. — MCM

Irving, E. *See* Haggerty, S. E. 03006

Irving, E. *See* Brooke, J. 03009

Irwin, Thomas D. *See* Sturgul, John R. 02987

02334 **Irwin, William P.; Greene, Robert C.; Thurber, Horace K.** Mineral resources of the Agua Tibia Primitive Area, California: U.S. Geol. Survey Bull. 1319-A, p. A1-A19, illus., table, geol. map, 1970.

Principal rocks of the Agua Tibia Primitive area (about 43 sq mi of the Cleveland National Forest) are crystalline and consist of both metamorphic and plutonic varieties. Metamorphic rocks have been correlated with those of Jurassic or older age, plutonic rocks are Cretaceous or perhaps older, and Pleistocene and younger sedimentary deposits cover much of the north and west perimeters. Temecula Arkose and other rocks are cut by faults, the largest of which are part of the Elsinore fault zone. No economic mineral deposits were found during the reconnaissance study. Analyses of more than 100 samples of stream sediments and bedrock did not indicate presence of geochemical anomalies; magnetic anomalies are believed related to gabbroic bedrock and not to economic deposits of magnetic minerals. — *from* Authors' abstract

02865 **Ismail, F. T.** Biotite weathering and clay formation in arid and humid regions, California: Soil Sci., v. 109, no. 4, p. 257-261, tables, 1970.

Examination of biotite fractions separated from a desert soil and a soil developed under humid conditions indicated that weathering of biotite resulted in the formation of vermiculite and montmorillonite under arid conditions and only vermiculite under humid conditions. Oxidation of the octahedral iron under neutral and alkaline conditions decrease the surface charge to produce montmorillonite. Acid conditions cause a decrease in the octahedral layer charge through the loss of iron and magnesium and the surface charge remains high producing vermiculite. — JWH

02884 **Iverson, N. L.** Riverbank stability study at the University of Alberta, Edmonton — Discussion [of paper by S. Thomson, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 169-170, 1970.

Iverson discusses the paper by Thomson (ibid., p. 157-168) and states that the most effective approach to the analysis of slopes is to determine the effective strength of a soil, either peak or residual, and to study the effect of varying pore pressures or piezometric levels on the factor of safety of unity. — EH

Jackson, M. L. *See* Mokma, D. L. 02545

02506 **Jacobs, J. A.** Geophysical numerology: Nature, v. 227, no. 5254, p. 161-162, 1970.

There has been a trend recently to seek empirical relationships between certain geophysical parameters in an attempt to simplify a problem. Such an approach has much to recommend it, but there is a danger in playing the "numbers game," for by algebraic manipulation we can sometimes obtain additional relationships which may be far from valid even within restricted ranges of some of the variables. Again, different workers may get incompatible relationships even though they approximately agree for certain ranges of the parameters. Examples are given. — DBV

02826 **Jacobs, J. A.** The evolution of the Earth's core and its magnetic field, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 513-518, illus., table, 1970.

The broad spectrum of variations in the Earth's magnetic field is discussed with particular reference to hydromagnetic oscillations in the Earth's core. Paleo-intensity measurements are reviewed and the effects on the magnetic field of the evolution of the core and of irregular fluctuations in the rate of the Earth's axial rotation are discussed. — Author's abstract

02486 **Jacobson, Roger L.; Langmuir, Donald.** The chemical history of some spring waters in carbonate rocks: Ground Water, v. 8, no. 3, p. 5-9, illus., tables, 1970.

The history of spring waters in carbonate rocks can be determined from chemical quality studies of these and associated ground waters. Median Ca^{2+}/Mg^{2+} ratio was 3.4 in 29 spring waters in the State College, Pa. area, indicating ground-water flow in limestone. Mean dissolved oxygen content was 7.7 mg/*l* or 71 percent of saturation consistent with subsurface flow under water-table conditions. Dissolved solids were added to spring waters during ground-water flow. Specific conductances ranged from 180-476 mho (mean 347 mho). CO_2 pressures were from $10^{-1.9}$-$10^{-2.6}$atm (mean $10^{-2.2}$ atm). The CO_2 gives spring waters the capacity to hold 3 times more hardness and alkalinity than streams in equilibrium with the atmosphere. Spring waters were undersaturated with respect to calcite and dolomite because of short residence times as ground water. Dye tracing of ground-water feeding springs in two drainage basins gave residence times of 2-6 days for subsurface flows of about 4,000 feet. Specific conductance and carbonate saturation data indicate that ground-water residence times of spring waters average longer than 2-6 days. — *from* Authors' abstract

02780 **James, H. L.; Pettijohn, F. J.; Clark, L. D.** Geology and magnetic data between Iron River and Crystal Falls, Michigan: Michigan Geol. Survey Rept. Inv. 7, 17 p., illus., table, geol. maps, 1970.

The area (about 42 sq mi along the northern Iron River-Crystal Falls basin) is underlain by folded strata of the Animikie Series (oldest to youngest: Badwater Greenstone, Dunn Creek Slate, Riverton Iron-formation, Hiawatha Graywacke, Stambaugh Formation, Fortune Lakes Slate). Minor stocklike masses and dikes of metagabbro and metadiabase are present locally; glacial cover is extensive. Structural elements are inferred chiefly from magnetic anomalies caused by the magnetic Stambaugh Formation. Several faults occur along the north margin of the basin. Much of the Riverton Iron-formation is unoxidized, and iron ore shipments from only two mines totaled about 2.5 million tons. Areas of outcrop, partial extent of mine workings, and drillhole and magnetic-survey data are shown on four geologic maps; a brief history of the mines and a description of known explorations are given. — *from* Authors' abstract

02816 **Jamieson, John C.** The phase behavior of simple compounds, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 201-203, 1970.

Polymorphic behavior of materials is of geophysical interest to ascertain density changes for equations of state and to determine the solid state physical properties of potential earth-forming materials. In this paper it is pointed out that "the phase behavior of simple compounds is not necessarily simple. Several examples are given in which either common approximations fail, or 'expected' phases do not appear; these include TiO_2, ZnO, and Ag-halides. In addition, an example is given of development of an inhomogeneous stress system in a situation where homogeneity is usually assumed." — VSN

02764 **Janssens, A.** Guidebook to the Middle Devonian rocks of north-central Ohio — Ohio Geol. Soc., Ann. Field Trip, 1970: [n.p.] Ohio Geol. Soc., 30 p., illus., 1970.

This guidebook for the annual field trip of the Ohio Geological Society on May 15, 1970 describes five quarry sections in north-central Ohio, between Columbus and Lake Erie, with special emphasis on the basal portion of the exposed Middle Devonian carbonates. The Detroit River rocks of northwestern Ohio are a facies of the Columbus Limestone, and the outcrop in north-central Ohio shows superposition of the two. — EH

Jarosewich, E. *See* Clarke, R. S., Jr. 02265

02635 **Jeffrey, D. A.; Zarrella, W. M.** Geochemical prospecting at sea [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 853-854, 1970.

02636 **Jeffries, F.** Applications of digitized logs in exploration [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 854, 1970.

Jenne, E. A. *See* Anderson, B. J. 02954

03005 **Johnson, A. H.** Jurassic Navajo Sandstone, a fold test for stability of remanent magnetization [abs.]: EOS, v. 51, no. 4, p. 271, 1970.

Johnson, G. H. *See* Hummel, F. A. 02446

02395 **Johnson, J. G.** Taghanic onlap and the end of North American Devonian provinciality: Geol. Soc. America Bull., v. 81, no. 7, p. 2077-2105, illus., tables, 1970.

The major marine onlap of the United States west of the Mississippi River, generally attributed to the Late Devonian, began as a late Middle Devonian event. Pre-Taghanic brachiopod faunas of eastern and western North America belong to the Appalachian and Old World provinces, respectively. The Taghanic onlap ended this isolation and provinciality of faunas. Taghanic brachiopods are described. — Author's abstract

02494 **Johnson, Kenneth S.; Nicholson, Alex.** Bibliography and index of Oklahoma geology, 1969: Oklahoma Geology Notes, v. 30, no. 2, p. 19-39, 1970.

The index contains 145 citations with a subject index.

02496 **Johnson, Kenneth S.** Salt produced by solar evaporation on Big Salt Plain, Woods County, Oklahoma: Oklahoma Geology Notes, v. 30, no. 3, p. 47-54, illus., tables, 1970.

High-purity salt (halite) is produced by solar evaporation of brine on the 4,000 acre Big Salt Plain on the Cimarron River in northwestern Oklahoma. Salt-saturated ground water, containing 343 g dissolved solids per liter of brine, is pumped at a rate of 500 to 1,000 gpm into earthen evaporating pans from wells 40 to 100 feet deep. NaCl makes up more than 98 percent of dissolved solids in the natural brine and over 98 percent of the solar salt. Nearly 7,300 tons of salt in bulk, bag, and brine was sold during 1969; salt was used primarily to de-ice roads, and brine as drilling fluid in oil and gas test wells. Annual production potential on Big Salt Pan is herein estimated at 1,000 tons of salt per acre of evaporating pan. — *from* Author's abstract

Johnson, P. H. *See* Martin, J. R. 02266

02781 **Johnson, Stanley S.; Sweet, Palmer C.** Gravity survey of Northampton and Accomack Counties, Virginia: Virginia Minerals, v. 16, no. 3, p. 21-26, illus., 1970.

Gravity patterns depicted by contours on the Bouguer anomaly map correspond in general to magnetic maps of the Eastern Shore area. The closed low (-27.0 mgals) south of Cheriton contains the lowest observed value; highest value was -7.2 mgals in the closed high between Exmore and Melfa. Magnetic maps show a closed magnetic low in the Chesapeake Bay area west of Cheriton which may be associated with the gravity low, but do not indicate a magnetic feature associated with the Exmore-Melfa gravity high, probably due to absence of a flight line through the anomalous gravity area. Low gravity values (-25.4 mgals) on Wallops Island seem to correspond to a magnetic low. The gradual increase in the gravity field from Wallops Island to the Exmore-Melfa area may reflect basement relief; relation of gravity and magnetic data in the Cheriton area reflect changes in basement lithology. — MCM

Jones, Robert L. *See* Davis, C. E. 02838

02778 **Jopling, A.** (committee chairman). Recommendations on the future development of geomorphology in Canada: Canadian Geographer, v. 14, no. 2, p. 167-173, 1970.

Summary recommendations of an *ad hoc* committee of the Canadian Association of Geographers are grouped as follows: scope of morphology, major research themes, present and future contributions of geomorphology to studies of earth science and related fields in Canada, research institutions and university professors, employment opportunities for geomorphologists, and travel and research funds. It is suggested that: geomorphology assume the status of an independent subject field, fundamental research be stressed, research facilities be established and maintained both in the field and in universities, better cooperation between government research agencies and universities be arranged, the discipline have a listing for employment opportunities, and a central authority coordinate research awards and develop uniformity in terms under which grants are made. — MCM

Jordan, Jane C. *See* Schiffman, Robert L. 02353

Jordan, T. *See* Anderson, Don L. 02811

02438 **Kaliser, Bruce N.** Environmental geology of the Bear Lake area, Utah, with application to planning in the intermountain West [abs.]: Mining Eng., v. 22, no. 1, p. 44-45, 1970.

02478 **Kalsbeek, Feiko.** The petrography and origin of gneisses, amphibolites and migmatites in the Qasigialik area, south-west Greenland: Medd. Grönland, v. 189, no. 1, 70 p., illus., tables, 1970; *reprinted as* Grönlands Geol. Undersögelse Bull. 83, 1970.

The geology and rock types of an area 200 km², 50 km south-southeast of Frederikshaab in southwestern Greenland, are described with special emphasis on the migmatites. Tables of mineral analyses of samples of gneisses, amphibolites and leucocratic veins are included, and also a discussion of the origin of the various rock types. Most of the rocks are believed to have been formed by isochemical metamorphism of geosynclinal sediments. — EH

Kanes, William H. *See* Donaldson, Alan C. 02607

02330 **Karig, D. E.; Peterson, M. N. A.; Shor, G. G.** Sediment-capped guyots in the Mid-Pacific Mountains: Deep-Sea Research, v. 17, no. 2, p. 373-378, illus., table, 1970.

Seismic reflection profiling across several guyots [Horizon, Hamilton, and Dietz] of the Mid-Pacific Mountains has revealed low domes of sediments above the basement summit platform. These domes are asymmetric, reflecting preferential erosion or nondeposition on the northern flanks, and are attributed to the action of deep currents on pelagic sediments deposited on guyots after they subside below wave base. Sets of terraces buried beneath the pelagic capping suggest that guyot subsidence was a complex process. — Authors' abstract

Karner, Frank R. *See* Furman, Marvin J. 02505

02736 **Karner, Frank R.; Connors, Roland A.** Composition, distribution, and orientation of xenoliths in the Tunk Lake Granite, Maine [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 16, 1970.

02407 **Karp, Stanley E.** Geologic technician, a new curriculum: Jour. Geol. Education, v. 18, no. 3, p. 132-134, 1970.

Bakersfield College, Bakersfield, Calif., offers a course for associate of arts degree for geologic technician. Its purpose is to train technicians to perform routine geologic tasks under the supervision of professional geologists in industry. The "Geo-tech" program requires a minimum of 63 1/2 semester units of basic courses, plus 15 semester units of optional courses. Fourth-semester students would be employed part-time by a company for "on-the-job-training" for credit. — EH

02554 **Karrow, P. F.** Pleistocene geology of the Thornhill area: Ontario Dept. Mines Indus. Mineral Rept. 32, 51 p., illus., tables, geol. map, 1970.

The Thornhill area on the north edge of Metropolitan Toronto, on Lake Ontario, has a surface relief of 500 feet, and bedrock relief of over 500; drift thickness generally ranges from 100-300 feet. The buried Laurentian Valley is cut into Ordovician shale and limestone nearly to sea level. Pleistocene deposits consist of a subsurface complex of tills and fossiliferous sediments probably ranging in age from Illinoian, through Sangamonian and Early Wisconsinan to Late Wisconsinan. Surface deposits consist of drumlinized silty to sandy Leaside Till, ice-marginal clay and silt, and deltaic sand. A succession of temporary glacial lakes formed during retreat of the Ontario ice lobe at approximately 800-825, 750, 680, 600, 550, 465-475, and 420-435 (Lake Iroquois) feet elevation. Deposits of economic interest include glaciolacustrine clay and sand and gravel. — *from* Author's abstract

02637 **Kauffman, Marvin E.; Campbell, Lyle.** Kinzers Formation, Appalachian analogue of Burgess Shale? [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 854, 1970.

Kaye, J. H. *See* Rancitelli, L. A. 02272

Kearney, P. C. *See* Woolson, E. A. 02866

02560 **Keech, C. F.** Groundwater levels in Nebraska, 1969: Nebraska Water Survey Paper 26, 83 p., illus., tables, 1970.

Selected wells from which measurements were made are strategically located to indicate net water-level changes and represent a variety of hydrologic conditions; all important aquifers are represented by at least one observation well. Only 35 of the 93 counties in Nebraska ended the 1969 year with average water levels in wells lower than the fall of 1968. — MCM

Keith, J. *See* Bogard, D. D. 02270

02638 **Keith, J. W.** Tectonic control of Devonian reef sedimentation, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 854, 1970.

02946 **Keller, George V.** Application of resistivity methods in mineral and groundwater exploration programs [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 51-66, illus., tables, 1970.

Direct-current resistivity methods, particularly in design of field equipment and interpretation of field data, have changed little in the past 20-30 years, but rapid advances are being made in design of field programs and evaluation of resistivity measurements in geologically meaningful terms. Electrode arrays used in field surveys have changed, and one may select an array best suited for a specific problem; the Schlumberger array provides greatest depth of penetration for a given amount of work while the dipole provides greatest safety in working in inhabited areas. Studies of relations between resistivity and other rock characteristics, such as porosity, texture, salinity of ground water, and content of ore minerals provide bases for evaluating measured resistivities, and for predicting probable success of surveys for specific exploration problems. — *from* Author's abstract

02978 **Kelly, Allan O.** Wind-rain ripple marks, a rare geomorphic phenomenon [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 57, 1970.

02750 **Kennard, William C.; Fisher, Jane S.** A bibliography of publications relating to water resources in Connecticut, 1900-1970: Connecticut Univ. Inst. Water Resources Rept. 10, 125 p., 1970.

The bibliography contains a section in which citations are grouped by subject, and another listed alphabetically by author. The subject index includes sections on: erosion, geology, geomorphology, ground water, hydrology, water quality, and water supply. — MCM

02291 **Kennett, James P.** Comparison of *Globigerina pachyderma* (Ehrenberg) in Arctic and Antarctic areas: Cushman Found. Foram. Research Contr., v. 21, pt. 2, p. 47-49, illus., table, 1970.

Populations of *Globigerina pachyderma* in Arctic bottom sediments exhibit distinct morphological differences from those in Antarctic bottom sediments. Arctic populations are less heavily encrusted, more lobulate, have a higher arched aperture, and have a dominance of 4 1/2-chambered forms (umbilical view), compared with a dominance of 4-chambered forms in Antarctic populations. Both are dominated by sinistrally coiling forms and they have similar size characteristics. Because of a shortage of morphological data on *G. pachyderma* in subArctic and northern hemisphere subtropical areas, it is not possible to determine whether these morphological differences result from phenotypic variation or subspeciation. Characteristic ranges of variation of *G. pachyderma* from both areas are illustrated by scanning-electron micrographs. — Author's abstract

02639 **Kent, Harry C.** Computer-based information bank for Cretaceous foraminifers from western interior region, United States and Canada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 854-855, 1970.

02701 **Kent, P. E.** Worldwide development in exploration field [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 855, 1970.

02640 **Kepferle, Roy C.; Peterson, Warren L.** Borden delta (Lower Mississippian) in north-central Kentucky [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 855, 1970.

02641 **Kerr, J. William.** Importance of continental drift to petroleum exploration [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 855, 1970.

03004 **Keys, W. Scott.** Borehole geophysics as applied to groundwater [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 598-612, illus.; discussion, p. 612-614, 1970.

Logging techniques applicable to ground-water investigations include: natural gamma, gamma-gamma, neutron-gamma, neutron-neutron, spontaneous potential, resistivity, caliper, sonic velocity, flowmeter, radioactive tracer, fluid resistivity, and gradient and differential temperature. Geophysical logs can be interpreted in terms of geometry, resistivity, bulk density, porosity, permeability, moisture content, and specific yield of aquifers, and source, movement, and chemical and physical characteristics of water. Information from interpretation is usually objective and consistent, logs are often the only means of obtaining information from old wells and lateral extrapolation of geologic and hydrologic conditions, logging can partially supplant coring with establishment of interpretation factors for a given environment, and logs provide continuous average values for a volume of material much larger than that of extracted samples. — *from* Author's abstract

Kim, Y. D. *See* Soderman, L. G. 02897

Kim, Young C. *See* Merriam, Richard. 02308

King, Billy Joe. *See* Tully, Philip C. 02839

02304 **King, Chi-Yu.** Acoustic efficiency of tensile fracture in glass: Earthquake Notes, v. 41, no. 1, p. 31-36, illus., table, 1970.

The preliminary result of an experimental study on the fracture of glass indicates that acoustic efficiency for tensile fracture is 80 percent or more, whereas the seismic efficiency for earthquakes and explosions has generally been estimated to be of the order of one percent for small shallow earthquakes. — MCM

02975 **King, James E.** Wisconsin-age boreal assemblages from the Ozarks of western Missouri [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 23, 1970.

King, L. H. *See* Phipps, C. V. G. 02448

02378 **King, Philip B.** Fossiliferous boulders in the Woods Hollow Shale, Marathon region, Texas — Discussion [of "Stratigraphy and sedimentology of the Woods Hollow Formation. . ." by E. F. McBride, 1969]: Geol. Soc. America Bull., v. 81, no. 6, p. 1843-1845, 1970.

Exotic fossiliferous boulders are common in parts of the Middle Ordovician Woods Hollow Shale. A sedimentary origin is indicated by the bulk of the evidence. An alternative origin, that the boulders are tectonic inclusions, was considered and rejected for the lack of evidence. [*See* McBride, ibid., v. 80, p. 2287-2302, 1969.] — EHP

02642 **Kinsman, David J. J.** Geochemistry, mineralogy, and occurrence of calcium sulfate minerals [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 855-856, 1970.

Kissling, Don L. *See* Howard, James F. 02386

Klein, Edward. *See* LeGeros, Racquel Z. 02803

02878 **Klein, Edward; LeGeros, John P.; Trautz, Otto R.; LeGeros, Racquel Z.** Polarized infrared reflectance of single crystals of apatites, *in* Developments in applied spectroscopy, V. 7B — Mid-America Spectroscopy Symposium, 19th Ann., Chicago, Ill., 1968, Selected papers: New York and London, Plenum Press, p. 13-22, illus., table, 1970.

Experiments are described using the polarized specular-reflectance technique to determine the dipole directions and relative intensities of the PO_4 vibrations in F-apatite and hydroxyapatite single crystals. Use of this information to make assignments of the frequency is discussed. — Authors' abstract

02731 **Kleiss, Harold J.** Hillslope sedimentation and soil formation in northeastern Iowa: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 287-290, illus., 1970.

Systematic investigation of a hillslope from summit to alluvial positions revealed that particle size variations within the soil A horizons are due to sedimentological sorting. The mean particle size in the surficial sediments follows a systematic decrease within two subset systems down the hillslope. Each subset is expressible mathematically. A discordance in the backslope position is caused by truncation of a sand zone within the till underlying the surficial material. Hillslope sedimentation has also influenced accumulation of organic matter, bulk density and cation exchange capacities in the soils formed at various positions on the slope. Profile characteristics indicate little pedogenic development; rather, many of the soil properties are inherited from the sedimentary nature of the hillslope surficial sediment. — Author's abstract

02430 **Kline, Charles H.** Industrial minerals in the world economy [abs.]: Mining Eng., v. 22, no. 1, p. 42, 1970.

Kling, S. A. *See* Bukry, D. 02723

Klovan, J. E. *See* Embry, A. F., 3d. 02613

Klovan, J. E. *See* Hitchon, Brian. 02630

Knox, E. G. *See* Carstea, D. D. 02569

02475 **Knox, Reed, Jr.** The yield strength of meteoritic iron: Meteoritics, v. 5, no. 2, p. 63-74, tables, 1970.

The compressive yield strength was determined on three meteorites using specimens 4 mm and 8 mm in length and strain magnification of 10,000 and 2,000 respectively, with an apparatus developed for testing small specimens of biological hard tissue. The flow stresses required to produce 0.2 percent plastic strain in a recrystallized Cañon Diablo specimen, in the Odessa octahedrite, and in the metal phase of a

Brenham were 62.9 K psi, 46.6 K psi, and 62.7 K psi, respectively. The flow stress of Cañon Diablo after heating in a vaccum for one hour at 871°C and furnace cooling was 60.0 K psi. The microstructure and grain size of the heat treated specimen was virtually that of the untreated meteorite. Plastic deformation of the Odessa specimen produced wavy slip lines in kamacite on a previously polished and etched surface. Slip lines also developed in taenite and cracks occurred in the phosphide phase. — Author's abstract

02310 **Koerner, R. M.** Some obersvations on superimposition of ice on the Devon Island Ice Cap, N.W.T., Canada: Geog. Annaler, v. 52A, no. 1, p. 57-67, illus., tables, 1970.

The zone of superimposed ice formation is defined and divided into two subzones, one of continuous and the other of discontinuous superimposed ice formation. Layering in superimposed ice is discussed and it is evident that an annual increment may consist of a series of layers which can occur in various orders according to the melt and freezing conditions obtaining. A laboratory analysis of superimposed ice did not reveal any valid method for division into annual layers. A crystal analysis indicates there is an increase in the mean crystal size and the standard deviation from this mean with decreasing altitude between the firn edge and the equilibrium line. Below the latter the pattern is reversed. This phenomenon is used to determine a long period equilibrium line. — Author's abstract

02989 **Kokalis, Peter G.** Terraces of the middle Salt River · alley, Arizona — [Pt.] 2, Size, shape, and lithologic characteristics of the alluvial sediments [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 64, 1970.

02906 **Kolipinski, Milton C.; Higer, Aaron L.** Remote-sensing applications to hydrobiology in south Florida, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 23-1—23-44, illus., table [1970].

Remote-sensing techniques were applied to hydrobiological investigations in the Everglades and coastal regions of south Florida. Panchromatic, color, color infrared and multiband photographs show hydrologic features such as depth and size of basins, drainage patterns, and distribution of aquatic and semiaquatic plants. The occurrence of mangrove trees along shorelines indicates mean high-water level. Particular reflections on photographs from algal mats and emergent aquatic plants permit delineation of the fresh-water/brackish-water interface. Multiband imagery shows potential in extracting spectral signatures of willow and fig trees and cattail marshes in the Everglades. The findings have transfer value to other marsh, swamp and coastal regions of the United States. — *from* Author's abstract

02457 **Komornik, A.; Zeitlen, J. G.** Laboratory determination of lateral and vertical stresses in compacted swelling clay: Jour. Materials, v. 5, no. 1, p. 108-128, illus., table, 1970.

A laboratory investigation is reported in which studies were made of both lateral and vertical pressure developed by a compacted clay, under different placement conditions, when various amounts of swell were permitted during saturation. Details are given of a special ring developed for measuring lateral pressures by use of a standard type of consolidometer. Methods of testing for expansion characteristics are described, as well as evaluation of the effect of varying test conditions and method of wetting. Relatively high lateral stresses were found, well in excess of the vertical stresses at low vertical loadings. — Authors' abstract

Koons, C. B. *See* Spencer, Derek W. 02686

02315 **Kornfeld, Joseph.** Smackover exploration increases in Mississippi: World Oil, v. 171, no. 1, p. 122-123, illus., 1970.

An accelerated exploratory and development drilling program is underway in 13 counties of central and southern Mississippi. Principal Jurassic targets are 15,000-23,000 feet deep. — Author's abstract

02745 **Kozak, Samuel J.** Geology of the Elliott Knob, Deerfield, Craigsville, and Augusta Springs quadrangles, Virginia: Virginia Div. Mineral Resources Rept. Inv. 21, 23 p., illus., tables, geol. maps, 1970.

These four quadrangles lie within the Valley and Ridge physiographic province; bedrock is sedimentary and ranges in age from Early Cambrian to Mississippian with total thickness probably exceeding 20,000 feet. Cambrian and Ordovician limestones, dolomites, and shales occur southeast of Little North Mtn., rocks of Silurian, Devonian, and Mississippian age to the northwest. Geologic structures have northeasterly strikes and intensity of deformation appears to decrease to the northwest; deformation occurred in post-Mississippian time, and possibly earlier. Mineral resources include limestones and dolomites; clay, shale, and related materials; silica sand, and iron ore. Devonian carbonate rocks and shales have been used in production of both portland and masonry cement and shales in the Brallier Formation for brick manufacture. — *from* Author's abstract

02643 **Kraft, John C.** Morphology and vertical sedimentary sequences in Holocene transgressive sand barriers [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 856, 1970.

02644 **Kramer, J. R.** Geochemistry and deposition of lower Salina Group, southwestern Ontario and Michigan [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 856, 1970.

Krasheninnikov, V. *See* Bukry, D. 02723

Krauss, Roland K. *See* Smith, R. M. 02728

02759 **Krinitzsky, E. L.** Radiography in the earth sciences and soil mechanics: New York and London, Plenum Press, 163 p., illus., tables, 1970.

02246 **Krogh, T. E.; Davis, G. L.** Metamorphism 1700 ± 100 m.y. and 900 ± 100 m.y. ago in the northwest part of the Grenville province in Ontario: Carnegie Inst. Washington Year Book 68, 1968-69, p. 308-309, illus., 1970.

02247 **Krogh, T. E.; Davis, G. L.** Isotopic ages along the Grenville front in Ontario: Carnegie Inst. Washington Year Book 68, 1968-69, p. 309-313, illus., 1970.

02248 **Krogh, T. E.; Brooks, C.; Hart, S. E.; Davis, G. L.** The Grenville front in the Chibougamau-Surprise Lake area, Ontario: Carnegie Inst. Washington Year Book 68, 1968-69, p. 313-314, illus., 1970.

Krouse, H. Roy. *See* Bailey, N. J. L. 02585

Krumbein, W. C. *See* Frazee, C. J. 02549

Kullerud, G. *See* Bell, P. M. 02228

Kullerud, G. *See* Bell, P. M. 02229

02249 **Kullerud, G.** Sulfide- and arsenide-type binary systems: Carnegie Inst. Washington Year Book 68, 1968-69, p. 256-259, table, 1970.

Kullerud, G. *See* Taylor, L. A. 02258

Kullerud, G. *See* Williams, K. L. 02260

Kulm, L. D. *See* Moore, T. C., Jr. 02458

Kume, Jack. *See* Bluemle, John P. 02480

Kunkle, George R. *See* Rowland, Mark R. 02489

Kunze, G. W. *See* Carson, C. D. 02571

Kushiro, I. *See* Erlank, A. J. 02239

02250 **Kushiro, I.; Schairer, J. F.** Diopside solid solutions in the system diopside-anorthite-albite at 1 atm and at high pressures: Carnegie Inst. Washington Year Book 68, 1968-69, p. 222-226, illus., table, 1970.

02251 **Kushiro, I.; Yoder, H. S., Jr.** Stability field of iron-free pigeonite in the system $MgSiO_3$-$CaMgSi_2O_6$: Carnegie Inst. Washington Year Book 68, 1968-69, p. 226-229, illus., 1970.

02252 **Kushiro, I.** Stability of amphibole and phlogopite in the upper mantle: Carnegie Inst. Washington Year Book 68, 1968-69, p. 245-247, illus., 1970.

02366 **Kushiro, I.** Systems bearing on melting of the upper mantle under hydrous conditions: Carnegie Inst. Washington Year Book 68, 1968-69, p. 240-245, illus., 1970.

LaChapelle, E. *See* Sommerfeld, R. A. 02459

Lam, Jörgen. *See* Pedersen, K. Raunsgaard. 02477

02872 **Lambert, I. B.; Wyllie, P. J.** Melting in the deep crust and upper mantle and the nature of the low velocity layer, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 316-322, illus., table, 1970.

It is possible that there are minor amounts of water in the upper mantle, which could significantly lower melting temperatures and may give rise to melts of different composition to those formed under anhydrous conditions. Experimental study of influence of water on phase relations in natural gabbro and tonalite samples at pressures from 10 to 25 kb is summarized; results are used in conjunction with recently published data for other rock-water systems to discuss melting in the upper mantle and lower continental crust. The low velocity zone in the upper mantle could be a layer of peridotite containing interstitial melt, which may be overlain by a layer of peridotite containing interstitial "water." Minimum possible temperatures for generation of andesite and basalt liquids are discussed; initial melt formed from wet peridotite may be andesitic. Granulite facies metamorphism in the lower continental crust and generation of "granites" are considered. — *from* Authors' abstract

Langmuir, Donald. *See* Jacobson, Roger L. 02486

Larew, H. Gordon. *See* Atakol, Kenan. 02360

02898 **LaRochelle, P.; Chagnon, J. Y.; Lefebvre, G.** Regional geology and landslides in the marine clay deposits of eastern Canada [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 145-156, illus., 1970.

A detailed inventory of the numerous landslides which have taken place in the Province of Quebec has shown that they are concentrated in given areas. Studies carried out in three areas revealed a coincidence between the concentration of landslides and the existence of valleys in the bedrock underlying the clay deposits. Piezometric levels measured in the field showed the prevalence of a downward gradient in the upper part of the slope and an upward gradient with artesian pressure at the toe. These flow conditions which can be imputed in part to the presence of the valley in the bedrock, produce the leaching of the salt in the pore water of the clay, resulting in a decrease of the shear strength and an increase of sensitivity of the clay. — Author's abstract

02481 **LaRocque, Aurèle.** Pleistocene Mollusca of Ohio, Pt. 4 (of 4 pts.): Ohio Div. Geol. Survey Bull. 62, pt. 4, p. 555-800, illus., 1970.

Terrestrial gastropods of 41 genera and 140 species and subspecies are described and figured, with type locality, ecology, general distribution of extant taxa, distribution in Ohio, and geologic range noted. Index maps for most of the species and subspecies show distribution (living and fossil) in North America and in Ohio. Land snails be-

long to orders which are also represented in aquatic habitats, but the families are distinct in all cases; the order Archaeogastropoda is represented here by one species of the family Helicinidae; the order Pulmonata is represented by 40 genera and 139 species and subspecies of the Carychiidae, Polygyridae, Achatinidae, Zonitidae, Limacidae, Endodontidae, Arionidae, Philomycidae, Succineidae, Strobilopsidae, Pupillidae, Valloniidae, and Cionellidae. — VMJ

Larocque, G. S. *See* Dussault, R. 02890

Larson, Donald A. *See* Leffingwell, Harry A. 02297

Lathan, Carl P. *See* Dodd, Philip H. 02929

02850 **Lathram, Ernest H.** Progress in application of remote-sensing techniques to marine geology and hydrology, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 17B1-17B2 [1970].

Three sites have been recommended for remote-sensing investigations of marine geology and hydrology. Preparatory to the acquisition of this data, ground studies, photography, and infrared data were acquired for the San Fransisco Bay, California, and Laguna Madre, Texas, areas. At the San Francisco Bay site infrared imagery and radiometric surveys were flown over a portion of the bay coincident with a systematic geochemical sampling of the water column and bottom sediments. Color photography of the southern coastal area of Texas, compared with ground-study data and earlier photography of Padre Island and Laguna Madre, showed westward migration of the dune field on Padre Island and rehealing of scars caused by a hurricane. — EH

02766 **Lauber, Patricia.** This restless Earth: New York, Random House, 129 p., illus., 1970.

Leach, Carolyn H. *See* Flawn, Peter T. 02784

Lee, Gerhard B. *See* Parker, Dale E. 02384

02355 **Lee, Kenneth L.; Seed, H. Bolton.** Undrained strength of anisotropically consolidated sand: Am. Soc. Civil Engineers Proc., v. 96, paper 7136, Jour. Soil Mechanics and Found. Div., no. SM2, p. 411-428, illus., 1970.

Strength of triaxial test specimens of saturated sand was investigated over a wide range of density, confining pressure, and anisotropic consolidation stress conditions; for any one initial density, volume changes during consolidation were a unique function of the major stress, independent of minor principal stress on the sample. Stress-strain curves and strengths determined from drained tests on initially identical samples consolidated to the same minor principal stress were almost independent of the principal consolidation stress ratio K_c. However, the undrained strength increased with increase in this ratio; at low confining pressures, it followed the same pattern established for isotropically consolidated undrained tests. For high pressures and high K_c conditions, the peak undrained strength was relatively high but unstable, and required only a minor increase in load to reduce the strength to a lower residual value similar to the strength predicted by previously established methods. — *from* ASCE abstract

Lefebvre, G. *See* LaRochelle, P. 02898

02297 **Leffingwell, Harry A.; Larson, Donald A.; Valencia, Mark J.** A study of the fossil pollen *Wodehouseia spinata* — [Pt.] 1, Ultrastructure and comparisons to selected modern taxa; [Pt.] 2, Optical microscopic recognition of foot layers in differentially stained fossil pollen and their significance: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 238-262, illus., 1970.

Pollen of *Wodehouseia spinata* Stanley, 1961, obtained from a sample of the Upper Cretaceous Lance Formation in east-central Wyoming, was studied with the scanning

and transmission electron microscopes. Apertures and wall stratification indicate that *Wodehouseia spinata* is an angiospermous pollen; its ektexine consists of a columella layer and a tectum, but lacks a foot layer; its endexine is a single, unstructured layer. The flange is formed entirely of ektexine, which separates from the endexine and protrudes in a narrow circumferential area about the grain; flange surfaces are closely appressed, and supported internally by long, radiating projections, which emerge through the tectum of the flange as small spines. The columella layer in the flange wall is reduced in height. Although *Wodehouseia* is grossly similar to *Impatiens*, *Beloperone*, and *Justicia*, its ultrastructure is so fundamentally different as to render any generic relationships extremely improbable. — *from* Authors' abstract

LeGeros, John P. *See* LeGeros, Racquel Z. 02803

LeGeros, John P. *See* Klein, Edward. 02878

02803 **LeGeros, Racquel Z.; LeGeros, John P.; Trautz, Otto R.; Klein, Edward.** Spectral properties of carbonate in carbonate-containing apatites, *in* Developments in applied spectroscopy, V. 7B — Mid-America Spectroscopy Symposium, 19th Ann., Chicago, Ill., 1968, Selected papers: New York and London, Plenum Press, p. 3-12, illus., tables, 1970.

A study of the infrared absorption spectra of carbonate-containing synthetic and biological apaties is reviewed. The implications of the results for the nature of the incorporation of the CO_3^{2-} ion into biological apatites is discussed. — Authors' abstract

LeGeros, Racquel Z. *See* Klein, Edward. 02878

02645 **Lennon, R. B.** Width-thickness relations for fluvial and shoreline sand bodies [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 857, 1970.

02935 **Lennox, D. H.; Carlson, V.** Integration of geophysical methods for groundwater exploration in the prairie provinces, Canada [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 517-533, illus., tables; discussion, p. 533-535, 1970.

In the Canadian prairies, geophysics has had two main uses as an aid in ground-water exploration: delineation of preglacial drainage pattern, mainly by seismic refraction, but also by resistivity; and mapping location and extent of buried permeable deposits, commonly by resistivity and gravity. All three methods depend on existence of appropriate subsurface physical contrasts which are absent in some areas on the basis of available density, resistivity, and seismic velocity data. Field results support the conclusion that none of the methods should find universal application to ground-water exploration in the prairies; data on physical properties indicate it is possible to map surficial and bedrock deposits on basis of regional variations. Knowledge of these variations is useful in assessing suitability of various methods and in planning an integrated approach to geophysical exploration. In most cases, data are insufficient for mapping purposes. — *from* Authors' abstract

02550 **Leonard, Ralph A.** Infrared analysis of partially deuterated water adsorbed on clay: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 339-343, illus., 1970.

Partially deuterated water (HDO) adsorbed on Na^+, K^+, Mg^{2+}, and Ca^{2+} saturated montmorillonite clays was studied by use of infrared spectroscopy. Positions of the primary O-D absorption band of adsorbed HDO were 2533, 2530, 2506, and 2526 cm^{-1}, respectively. In addition, a small secondary band was found at 2670 cm^{-1}. This band may arise from an O-D group very weakly H-bonded to a surface oxygen, or to water isolated in hexagonal cavities in the surface. No evidence of strong H-bonding to the mineral surface was evident. Findings indicate that at low water contents, the exchangeable cation exerts the dominate force affecting the structure of the adsorbed water. — Author's abstract

Letourneau, Nelson J. *See* Sutton, George H. 02779

Lettau, Heinz H. *See* Gallimore, Robert G., Jr. 02833

02998 **Levitt, S. R.; Condrate, R. A., Sr.** The polarized infrared spectra of hydroxyl ion in fluorapatite: Appl. Spectroscopy, v. 24, no. 2, p. 288-289, illus., 1970.

The polarized ir spectra of thin crystal sections of natural fluorapatite have been obtained in the region from 4000 to 1800 cm^{-1}. On the basis of these spectra, the orientation of impurity hydroxyl ions trapped within the fluorapatite lattice is suggested. In large crystals from Durango, Mexico, X-ray patterns were typical of highly crystalline fluorapatite; thin sections were cut parallel to their c-axes. Polarized ir spectra obtained with a single-crystal section are illustrated. Two bands, about 3500 cm^{-1}, found in the region where hydroxyl ion stretching modes occur, decrease in intensity with decreasing thickness; possible explanations are given, but further investigation is needed. — GDC

02737 **Levy, Ram L.; Wolf, Clarence J.; Grayson, Michael A.; Gilbert, J.; Gelpi, E.; Updegrove, W. S.; Zlatkis, A.; Oró, J.** Organic analysis of the Pueblito de Allende meteorite: Nature, v. 227, no. 5254, p. 148-150, illus., table, 1970.

The Pueblito de Allende meteorite, a Type III carbonaceous chondrite, fell on February 8, 1969, at an opportune time, when various laboratories were preparing for an organic analysis of lunar material using highly refined analytical techniques. Analysis of the meteorite by step-wise volatilization-pyrolysis indicates the presence of 16 kinds of organic compounds. Three important experimental observations suggest that much of this organic material is indigenous to the meteorite and not due to contamination: there is more organic material on the inside of the meteorite than outside; 75 percent of the compounds are released at temperatures too low to be thermal decomposition products from larger molecules; and the primary pyrolysis products are alkylbenzenes and alkanes. — DBV

Liebermann, Robert C. *See* Anderson, Orson L. 02814

Lilley, E. M. *See* Stephens, D. R. 02402

Lindsay, Everett H. *See* Lundin, Robert F. 02982

Lindsay, W. L. *See* Norvell, W. A. 02552

Lindsley, D. H. *See* Haggerty, S. E. 02242

Lineback, Jerry A. *See* Howard, James F. 02386

02646 **Lintz, Joseph, Jr.** Remote sensing for petroleum [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 857, 1970.

02647 **Lloyd, R. Michael.** Application of stable oxygen and carbon isotope techniques to studies of diagenesis [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 857, 1970.

02421 **Lo, K. Y.** The operational strength of fissured clays [with French abs.:] Géotechnique, v. 20, no. 1, p. 57-74, illus., tables, 1970.

In clays that are generally but not necessarily stiff, fissures and joints exist with varying intensity, constituting planes of weakness, along which shear strengths are much less than those of the intact material, depending on size of the sample used. Previous theories on the strength-size relation are reviewed, and limitations discussed. An equation is proposed to describe this behavior and a method for determining the parameters involved. Analyzed results of field and laboratory tests on block samples of Nanticoke clay [Ontario] and data reported in the literature showed that the strength-size relation may be thus represented adequately, and strength of the clay mass operative in the field may be predicted. By accounting for effect of sample size, anisotropy and time failure, the conventional $\phi=0$ analysis, thought unreliable when applied to fissured clays, may be used for short-term stability problems if the undrained condition is satisfied. — *from* Author's abstract

Lo, K. Y. *See* Milligan, V. 02899

Longley, W. W. *See* Harrison, J. C. 02791

02375 **Lorenz, Volker.** Some aspects of the eruption mechanism of the Big Hole maar, central Oregon: Geol. Soc. America Bull., v. 81, no. 6, p. 1823-1829, illus., table, 1970.

At Big Hole maar in central Oregon, rising basalt magma came in contact with abundant ground water at a depth of more than 200 m below the surface, causing phraetomagmatic eruptions, possibly 20,000 yr ago. Late-stage subsidence along a ring fault accounts for the large crater cut into older rocks. Subsequent erosion of pyroclastic debris in the crater wall increased diameter of the crater while decreasing its depth. Investigation of the distribution pattern of large ejected blocks and application of a model of block acceleration in a dense rising two-phase system permits calculation of the *apparent* density and velocity of the fluid system. Vesiculated tuffs, present between 1 and 2.5 km from the center of the crater, appear to be deposits of *base surges.* — *from* Author's abstract

Louis, H. *See* Stephens, D. R. 02402

02854 **Love, D. S.** Infrared studies, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 51-1 — 51-17, illus., table [1970].

Advantages and disadvantages of current infrared scanners used by the NASA Remote Sensing Aircraft Program for thermal mapping and multispectral sensing are discussed. Optical-mechanical scanners have many advantages over cameras of comparable resolution, and improvements in them are rapidly being made. Specifications have been developed for a new multispectral scanner, covering the spectral interval of 0.32μ to 13.5μ in as many as 29 bands with perfect time and space registration. Tonal distortions produced by ac-coupled imaging systems are being corrected by using dc-restoration, or clamping. The problem of improving the recording medium for the scanner signal, which, at present, has a limited dynamic range, is being studied. — EH

02572 **Lowell, J. D.** Copper resources in 1970: Soc. Mining Engineers AIME Trans., v. 247, no. 2, p. 97-103, 1970.

A broad look at the copper picture from the beginnings of the industry in 3,300 B.C. is presented in this 1970 Jackling Lecture, with a careful examination of the prospects for copper exploration, production and consumption up to the year 2,000. The geology of porphyry copper deposits is described briefly. A resurgence of underground mining, a continuing trend toward exploitation of lower-grade deposits, a continuing price climb and a consumption increase of about 2 1/2 times by the year 2000 are predicted. — *from* Author's abstract

02648 **Lumsden, D. M.** Markov chain analysis of carbonate rocks — Applications, limitations, and implications as exemplified by Pennsylvanian carbonates in southern Nevada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 857-858, 1970.

02982 **Lundin, Robert F.; Lindsay, Everett H.** An oreodont (Mammalia: Artiodactyla) from central Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 63, 1970.

02574 **Lutton, R. J.** Rock slope chart from empirical slope data: Soc. Mining Engineers AIME Trans., v. 247, no. 2, p. 160-162, illus., 1970.

Empirical data from 91 rock excavations have been used to construct a family of slope curves on a chart relating excavation height and inclination. The highest and steepest slopes from each excavation are plotted and connected by a line. The 91 lines appear to establish one or two geometrical slope fields through which the curves are projected. The curves apparently represent a lumped effect of many factors too complex to be considered individually. Important factors such as geological structure or ground-water conditions can dominate the picture, but where these factors do not

overshadow others, the slope charts should be useful for estimating or checking optimum inclination. — Author's abstract

02862 **Lyles, Leon; Dickerson, J. D.; Disrud, L. A.** Modified rotary sieve for improved accuracy: Soil Sci., v. 109, no. 3, p. 207-210, illus., tables, 1970.

Three versions of rotary sieves (original, improved, and compact) were tested. Substantial errors were noted; consequently, a modified version was developed. This version showed marked improvement in sieving accuracy. Improvements included changes in feeding mechanism, power transmission, and location of various mesh sizes relative to each other. — JWH

02941 **Mabey, D.; Garland, G. D.; Hollister, J. C.; Dash, B. P.; Brown, J. M.; Parasnis, D. S.** Human resources and geophysical exploration, *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 709-719, 1970.

Mabey and Garland as chairmen of this panel discussion review problems in obtaining and retaining an adequate geophysical staff, and institutions producing geophysical talent, respectively. The other panel members contributed summaries as follows: Dash on supply and demand of earth-science manpower in Great Britain, Brown on problems of obtaining geophysicists for the U.N. mineral exploration programs, Hollister on geophysics at the Colorado School of Mines, and Parasnis on the situation in Sweden. This is concluded with a general panel discussion. — MCM

02944 **Mabey, Don R.** The role of geophysics in the development of the world's groundwater resources [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 267-271, illus., 1970.

All standard geophysical methods have found some use in ground-water exploration, electrical and seismic for surface, and electrical and gamma-ray logs for borehole methods. Adequate geophysical support requires that all standard techniques be available when needed, but many ground-water programs have suffered from attempts to solve all problems by only one or two. The trend in ground-water investigations is toward a regional basis rather than a single well or field, a program that requires a properly designed and executed program of geophysics. Exploration geophysics has not played as important a part in ground-water investigation as in petroleum and mineral exploration, the result mainly of economic considerations. As the value of fresh water increases and awareness of long-range problems becomes more acute, use and effectiveness of geophysical techniques will expand. — *from* Author's abstract

02901 **MacDonald, A. B.; Sauer, E. Karl.** The engineering significance of Pleistocene stratigraphy in the Saskatoon area, Saskatchewan, Canada [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 116-126, illus., table, 1970.

Repeated stages and substages of glaciation in Saskatchewan during the Pleistocene produced a series of overlapping sediments which could be analyzed for engineering purposes within a three-dimensional stratigraphic framework. Preliminary field investigations indicated that a stratigraphic analysis could be related to construction problems found on highway embankment construction, gravel location, and tunnel excavation, and established that it is practical for the field engineer to analyze and interpret stratigraphy in the field. Laboratory studies indicated significant differences in engineering properties of different drift-stratigraphic units. The behavior of till units during construction can be explained in terms of fundamental engineering properties of soils such as shear strength parameters and compressibility. — *from* Author's abstract

02823 **MacGregor, Ian D.** The effect of CaO, Cr_2O_3, Fe_2O_3, and Al_2O_3 on the stability of spinel and garnet peridotites, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 372-377, illus., tables, 1970.

The reaction pyroxene + spinel ⇌ garnet + olivine defines the boundary between low pressure spinel peridotite and high pressure garnet peridotite. Experimental determination in the system MgO-CaO-Al_2O_3-SiO_2 indicates that CaO content is critical in defining position of the reaction boundary. Experiments on clinopyroxenes, orthopyroxenes and spinels from ultramafic nodules, indicate that the reaction boundary moves to higher pressures with increasing Cr_2O_3 and Fe_2O_3 and decreasing Al_2O_3 contents. Variations in the trivalent oxide ratio may result in changes of equilibrium by as much as 10 kb. Results indicate that mantle composition is critical in defining the position of the spinel-to-garnet-peridotite boundary, and leaves open the possibility that spinel and garnet peridotite may coexist throughout a wide depth within the Earth's upper mantle. — *from* Author's abstract

Mack, Douglas E. *See* Shelton, John W. 02350

02517 **Mackasey, W. O.** Summers Township, District of Thunder Bay: Ontario Dept. Mines Prelim. Geol. Map P. 602, scale 1 in. to 1/4 mi., text, 1970.

The text for Summers Township is the same as that for Eva Township (Map P. 601, Mackasey, 1970). — MCM

02732 **Mackasey, W. O.** Eva Township, District of Thunder Bay: Ontario Dept. Mines Prelim. Geol. Map P. 601, scale 1 in. to 1/4 mi., text, 1970.

Oldest rocks in Eva Township are early Precambrian metavolcanics and metasediments; north-trending diabase dikes are present throughout the area. Rocks form part of an east-west fold belt, with sediments mostly overturned to the north; west-plunging drag folds are abundant. Gold, silver, sulfur, iron, and sand and gravel are resources of economic interest. — MCM

02649 **Mackenzie, Fred T.; Garrels, Robert M.** Diagenesis of shaly rocks [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 858, 1970.

Mackenzie, Fred T. *See* Vacher, H. Leonard. 02693

02948 **MacLeod, Norman S.; Snavely, Parke D., Jr.** Radar and infrared imagery, Oregon and Washington coasts, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 17A1-17A8, illus. [1970].

Radar and infrared imagery are being used to study the geology of coastal Washington and Oregon. High-frequency side-looking radar was used for a 10-mile-wide coastal strip from the Columbia River almost to the California border. Infrared imagery in the 8μ to 14μ range was used for a 2 1/2 to 3-mile strip from near Cape Flattery, Washington, to near Seaside, Oregon, an area of dense vegetation cover and thick soils, to test effectiveness of radar and infrared imagery in field studies and to check the known geology. Radar shows more detail than photography and facilitates recognition of lithologic and structural features and topographic lineations. On photographs vegetation degrades topographic expression. Infrared imagery was usable only for the area in Washington. Significant features shown were current patterns, faults, submerged reefs, fresh-water springs, and plumes off river mouths. — EH

Macqueen, R. W. *See* Petryk, A. A. 03014

Madariaga, Raul. *See* Weidner, Donald. 03013

02650 **Magnusson, Don H.** Sable Island deep test of Scotian shelf [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 858, 1970.

02387 **Malloy, R. J.; Hurley, R. J.** Geomorphology and geologic structure, Straits of Florida: Geol. Soc. America Bull., v. 81, no. 7, p. 1947-1972, illus., table, 1970.

Detailed bathymetric studies, as well as seismic reflection and previous seismic refraction studies suggest that the main axis of the Northern Straits of Florida has formed largely by nondeposition and limited erosion, and that the Southern Straits (north of Cuba) have formed largely by subsidence and normal faults along Cuba to form a half-graben with the down-dropped portion tilted toward the south. The axis of greatest depth of the Southern Straits therefore lies only 17 n.m. north of Cuba. Elongate depositional anticlines occur at the base of steep slopes, and are separated from these by nondepositional troughs, apparently related to contour currents. Pourtales and Miami Terrace are marked with karst-like topography, which probably formed subaqueously. The morphology of the Northern Straits locally has been reshaped by coral growth. Eroded strata crop out along the thalweg of the Northern Straits and locally along the bases of scarps. — ER

Mamet, B. L. *See* Toomey, Donald Francis. 02292

Mamet, B. L. *See* Petryk, A. A. 03014

02651 **Manheim, F. T.** Critique of membrane-filtration concepts as applied to origin of subsurface brines [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 858, 1970.

02652 **Manheim, F. T.; Chan, K. M.; Sayles, F. L.** Chemical composition of oceanic water during Tertiary time; evidence from pore-water studies on JOIDES drill cores [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 858-859, 1970.

Mao, H. K. *See* Bell, P. M. 02226

02253 **Mao, H. K.; Schairer, J. F.** Quenching experiments in the system jadeite ($NaAlSi_2O_6$)-forsterite (Mg_2SiO_4) and jadeite ($NaAlSi_2O_6$)-anorthite ($CaAl_2Si_2O_8$): Carnegie Inst. Washington Year Book 68, 1968-69, p. 221-222, 1970.

02254 **Mao, H. K.; Takahashi, T.; Bassett, W. A.** Study of lead up to 180 kb: Carnegie Inst. Washington Year Book 68, 1968-69, p. 251-253, table, 1970.

02255 **Mao, H. K.; Bassett, W. A.; Takahashi, T.** High-pressure phase transformation in magnetite: Carnegie Inst. Washington Year Book 68, 1968-69, p. 249-251, tables, 1970.

02812 **Mao, H. K.; Takahashi, Taro; Bassett, William A.** Isothermal compression of the spinel phase of Ni_2SiO_4 up to 300 kilobars at room temperature, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 51-53, illus., table, 1970.

The effect of pressure on the lattice parameter, hence the volume, for the high-pressure spinel phase of Ni_2SiO_4 has been determined at room temperature up to 300 kb by means of the X-ray diffraction method employing a diamond-anvil high-pressure cell. The isothermal bulk modulus was calculated to be 2.14 ± 0.07 Mb by a least squares fit of the experimental data to the Birch-Murnaghan equation. This value is consistent with the Anderson-Nafe relationship, but deviates from the seismic equation of state of D. L. Anderson. — Authors' abstract

Mark, Norman. *See* Sutton, George H. 02779

Marshall, P. Anthony. *See* Healy, J. H. 02792

02460 **Martin, B. F.** A study of rhodolite garnet: Jour. Gemmology, v. 12, no. 2, p. 29-36, illus., 1970.

A rose-red gemstone classified as rhodolite — a subvariety in the pyrope-almandine garnet series — and supposedly from Mason's Mountain, Macon County, North Carolina, was examined for data that might be helpful in its identification. Its refractive index of 1.758 lies within the range of pyrope, yet the rose-red to pale violet color is different, while spectroscopy reveals three main absorption bands of alman-

dine of moderate intensity. Comparison was made with eleven large cut stones of correct color but unknown source. Inclusions seen under a 10x lens only in the "Carolina" stone, but revealed by microscope also in four of the test stones, were of two types: orientated needles, and crystals, almost certainly of apatite. The lower R.I. of the test stones (an average 1.747), and different habit of their inclusions, suggest another source; their large size and fine quality point to a Tanzanian origin. — GDC

02266 **Martin, J. R.; Johnson, P. H.; Nance, W. B.; Allen, J. H.** Analytical chemical and X-ray diffraction analysis of the Lost City meteorite [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

Martin, L. *See* West, G. F. 02958

02530 **Martin, Larry D.** Two microtine phylogenetic lineages [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 35, 1970.

02868 **Martini, J. A.** Allocation of cation exchange capacity of soil fractions in seven surface soils from Panama and the application of a cation exchange factor as a weathering index: Soil Sci., v. 109, no. 5, p. 324-331, illus., tables, 1970.

In recent volcanic soils, the CEC tends to be relatively high. In older volcanic soils, it tends to be relatively low. In young alluvial soils and in planosol, the CEC is relatively high. The weathering index or cation exchange factor was obtained by dividing the clay activity by the percent of clay. This index was applied to the soil data to place the soils in a certain weathering sequence. — *from* Author's summary

Mason, Shirley L. *See* Mather, Kirtley F. 02758

02306 **Matalucci, Rudolph V.; Abdel-Hady, Mohamed; Shelton, John W.** Influence of grain orientation on direct shear strength of a loessial soil: Eng. Geology, v. 4, no. 2, p. 121-132, illus., tables, 1970.

Experimental results indicate that preferred orientation of skeletal grains of Vicksburg loess has a significant influence on directional shear strength. Shear strength is greater where specimens are sheared perpendicular to grain orientation, and lower strength exists where specimens are sheared parallel to particle orientation. Strength variations range from 9-12 percent. Failure planes developed parallel to grain orientation produce off-lapping, short, discontinuous (en echelon) fractures, whereas a uniform, continuous fracture develops normal to grain orientation. Failure surfaces of direct shear tests also reveal steplike features which face the oncoming opposed surface. — Authors' abstract

02758 **Mather, Kirtley F.; Mason, Shirley L.** A source book in geology, 1400-1900: Cambridge, Mass., Harvard Univ. Press, 702 p., illus., reprinted 1970; originally published 1939.

02472 **Matson, Robert E.** Preliminary report, strippable coal resources, McCone County, Montana: Montana Bur. Mines and Geology Bull. 78, 13 p., illus., tables, 1970.

In a reconnaissance of the coal resources of the S coal bed in McCone County during late summer of 1968, seventeen holes were drilled, and five cores were taken to determine the extent, thickness, and quality of the S coal bed, which is in the Tongue River Member of the Fort Union Formation. Analyses of the cores rank the coal as lignite A. Two strippable coal deposits are outlined, the Weldon-Timber Creek deposit, which has indicated reserves of 724 million tons, and the Redwater deposit, which has indicated reserves of 642 million tons, a total of 1,366 million tons. — Author's abstract

02714 **Matsumoto, Mayme; Nichols, Rachel.** (compilers). Bibliography of vertebrate paleontology and related subjects, 1968-1969: Soc. Vertebrate Paleontology Bibliography, no. 24, 46 p., 1970.

Entries are arranged alphabetically by author; there is no index or serial list.

02653 **Matthews, R. K.** Process approach to diagenesis of reefs and reef-associated limestone [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 859, 1970.

02406 **Mayer, Victor J.** A field course for undergraduate earth science education majors: Jour. Geol. Education, v. 18, no. 3, p. 129-131, 1970.

The course described in this paper, offered by Ohio State University, is one of the few summer field courses, if not the only one, especially designed and taught for the undergraduate earth science education major. The field work teaching is described and results of the course evaluated. — EH

02309 **McBride, Earle F.; Thomson, Alan.** The Caballos Novaculite, Marathon region, Texas: Geol. Soc. America Spec. Paper 122, 129 p., illus., table, 1970.

The Caballos Novaculite in the Marathon Basin in Texas, a lens-shaped unit consisting of five members of bedded chert, is conformable with the underlying Maravillas Formation of Late Ordovician age and with the overlying Tesnus Formation of Mississippian to Early Pennsylvanian age. The chert is formed by the diagenetic alteration of opaline skeletal particles, chiefly sponge spicules and Radiolaria. Novaculite (snow-white chert) owes its lack of color to the absence of detrital impurities and chemical pigments, and its milkiness to the dispersion of light by minute water inclusions and reflecting faces of microgranular quartz crystals. A detailed study of the petrography and petrogenesis of the bedded chert and associated beds of the Caballos Novaculite are included. — *from* Author's abstract

02381 **McCammon, Richard B.; Wenninger, Guenther.** The dendrograph: Kansas Geol. Survey Computer Contr. 48, 28 p., illus., tables, 1970.

The dendrograph has been developed as a two-dimensional diagram for depicting the mutual relationships among a group of objects whose pairwise similarities are given. The construction of the dendrograph is based on results of clustering using the unweighted pair-group method. The resultant hierarchical arrangement reflects both the within-group and the between-group similarity. In order to accentuate the hierarchical group structure, a rule of ordering is used to impart a pyramid shape to the dendrograph. To allow greater flexibility in the computer program for constructing dendrographs, an option is provided for the user to enter either correlation coefficients or distance functions as the measure of pairwise similarity between objects. Two examples are given to illustrate the usefulness of dendrographs in extracting meaning from multivariate data arrays. — Authors' abstract

02654 **McCammon, Richard B.** Pattern recognition as guide for establishing minimum sampling requirements in regional stratigraphic studies [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 859-860, 1970.

02910 **McCoy, Roger M.** Application of radar imagery to drainage analysis, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 27-1 — 27-18, illus. [1970].

This study is based on comparison of drainage-basin data from imagery from a K-band imaging system and from topographic maps at the scale of 1:24,000. For mapping purposes the presentation of stream networks on the radar imagery was good for low-order streams, but detail was lost for first-order streams. For analyzing drainage systems, parameters derived from the imagery included numbers and lengths of streams, areas of basins, and regional slope. This imagery was also better for second-order or higher streams. For drainage-basin analysis radar imagery is especially promising for covering large areas. At present stream data is obtained from radar imagery manually, but scanning methods can now analyze drainage basins quantitatively and convert data directly to a map equivalent. This edge-enhancement method is of value in obtaining total length of stream networks. — EH

McCracken, R. J. *See* Gamble, E. E. 02577

02262 **McCrosky, R. E.; Shao, C. -Y.** Lost City meteorite — Recovery and preliminary analysis of the trajectory data [abs.]: EOS, v. 51, no. 7, p. 580, 1970.

02316 **McCulloch, David S.; Bonilla, Manuel G.** Effects of the earthquake of March 27, 1964, on the Alaska Railroad: U.S. Geol. Survey Prof. Paper 545-D, p. D1-D161, illus., tables, 1970.

In the 1964 earthquake the Alaska Railroad sustained damage of more than 35 million dollars to port facilities, roadbed and track, buildings and utilities, bridges and culverts, and landslide removal. Principal causes of damage were: landslides, landslide-generated waves, and seismic sea waves; regional tectonic subsidence; and a general loss of strength experienced by wet water-laid unconsolidated granular sediments. The term 'landspreading' is proposed for the lateral displacement and distension of mobilized sediments. Landspreading generated stress that produced cracks in the ground surface adjacent to depressions, occurred over large areas, caused embankment settlement, and was accompanied by transient horizontal displacement of the ground. Total thickness of unconsolidated sediments strongly controlled degree of damage; local geology and physiography largely controlled kind, distribution, and severity. — *from* Authors' abstract

02476 **McDougall, David J.** Natural thermoluminescence of calcareous rocks from the Charlevoix (Malbaie) structure: Meteoritics, v. 5, no. 2, p. 75-83, illus., table, 1970.

The natural thermoluminescence of samples of limestone from within and near the Charlevoix meteorite impact structure [Quebec] indicates that the effect of impact, strain due to faulting, low-grade thermal metamorphism, and recrystallization can often be distinguished on the basis of the shape and either the total emission or amplitude of the peaks of the thermoluminescence curves. Impact causes a reduction of thermoluminescence which is detectable in the Charlevoix structure for about 10 km outside the known limits of shatter cone development. It is inferred that thermoluminescence investigations should provide a useful means of investigating other impact structures. Impact effects on quartz rich rocks appear to be somewhat similar to the effects in calcareous rocks, but a fundamental difference in the electronic properties of shocked quartz and calcite demonstrate that identical effects should not be anticipated. — Author's abstract

02770 **McDougall, Robert B.** Mineral resources at six reservoir sites in the Blue River basin, Johnson County, Kans., and Cass County, Mo., *in* Blue River, vicinity of Kansas City, Missouri and Kansas: U.S. Cong., 91st, 2d sess., House Doc. 91-332, p. 108-120, tables, 1970.

The feasibility of reservoir construction for flood control and water conservation in the Blue River basin is being considered at five sites in Johnson County, Kans., and one in Cass County, Mo. Intermittent limestone and shale beds of the Pennsylvanian Kansas City Group are exposed in the Kansas City area; erosion-resistant limestone beds commonly cap hills and support upper slopes of valleys, whereas more generally shale is bedrock in lower valley slopes and valley floors. Limestone is produced from the Argentine and Farley Members of the Wyandotte Formation for crushed stone for concrete aggregate and road construction, and petroleum from the Cherokee Formation. Several quarry sites are within or adjacent to proposed reservoir sites; construction of the proposed reservoir would require protection, modification, or relocation of five pipelines. — MCM

02825 **McGetchin, Thomas R.; Silver, Leon T.** A crustal-upper mantle model for the Colorado Plateau based on observations of crystalline rock fragments in a kimberlite dike [abs.], *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 471, 1970.

02508 **McIlwaine, W. H.; Meyn, H. D.; Card, K. D.** Operation Maple Mountain — Smoothwater Lake area, Districts of Sudbury and Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 584, scale 1 in. to 1 mi., text, 1970.

The Smoothwater Lake area is underlain by Precambrian rocks, overlain unconformably by unconsolidated Cenozoic deposits of sand, gravel, and clay of glacial and glaciofluvial origin. The chief structural feature, the main Huronian depositional basin, was probably formed in part by faulting; the two main fault systems strike NW and NE. Major folds are open, dome and basin structures with low, variable axial

plunges. Archean metavolcanics have mineral assemblages characteristic of the almandine amphibolite facies of regional metamorphism and in part have been granitized and are migmatitic. Most sulfide mineral occurrences are associated with Nipissing Diabase intrusions. Uranium mineralization is in the lower part of the Mississagi Formation; iron formation in Cotton Township has been estimated as having a potential tonnage of 10 million tons grading 20 percent Fe. — MCM

02509 **McIlwaine, W. H.; Meyn, H. D.; Card, K. D.** Operation Maple Mountain — Lady Evelyn Lake sheet, Districts of Nipissing, Sudbury and Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 585, scale 1 in. to 1 mi., text, 1970.

For general geology of the Lady Evelyn Lake sheet, *see* Prelim. Geol. Map P. 584 (McIlwaine, 1970). Sulfide mineral occurrences are associated with the Nipissing Diabase intrusions; main minerals are galena, native silver, and Co-Ni-Fe arsenides. Part of the Kokoko Lake iron formation is exposed around Ferrim Lake; indications are it is 300-1,000 feet thick and grades 25-40 percent iron over widths of 500 feet. — MCM

McIlwaine, W. H. *See* Wolfe, W. J. 02516

McIlwaine, W. H. *See* Wolfe, W. J. 02734

McIntyre, James R. *See* Peterson, Norman V. 02773

02392 **McKee, Bates; Stradling, Dale.** The sag flowout, a newly described volcanic structure: Geol. Soc. America Bull., v. 81, no. 7, p. 2035-2043, illus., table, 1970.

Structures in the Columbia River Basalt around Odessa, Washington, are interpreted as forming by downward sag and foundering of the crust of a partly solidified flow, and upward escape of lava from the fluid interior along outward-dipping concentric dikes. The resulting structure, herein termed a sag flowout structure, is described in the belief that similar structures will be found elsewhere in flood basalts. — Authors' abstract

03000 **McKenzie, Garry D.** Some properties and age of volcanic ash in Glacier Bay National Monument: Arctic, v. 23, no. 1, p. 46-49, illus., table, 1970.

Volcanic ash occurs in one section of marine sediments in Granite Canyon in the eastern part of Glacier Bay National Monument, southeastern Alaska. Radiocarbon dates on wood from marine deposits of nearby localities indicate the ash was deposited about 11,000 yr B.P., although no date is available for the section of the Forest Creek Formation that contains the ash. Mount Edgecumbe, near Sitka, may have been the source of the ash. Results of granulometric, petrographic, and partial chemical analyses of samples are given. — EH

02655 **McMillan, Neil J.** Marine geology of eastern continental margin of Canada [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 860, 1970.

McMurry, H. V. *See* Callahan, William H. 02927

McMurtrey, R. G. *See* Reed, T. E. 02473

McNally, N. K. *See* Bennett, G. 02513

McNally, N. K. *See* Bennett, G. 02733

02980 **McNerney, John J.; Buseck, Peter R.** Mercury vapor used for geochemical exploration [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 62-63, 1970.

02881 **McPherson, H. J.** Landforms and glacial history of the upper North Saskatchewan Valley, Alberta, Canada [with French abs., p. 89]: Canadian Geographer, v. 14, no. 1, p. 10-26, illus., 1970.

The upper North Saskatchewan valley contains evidence for two glacial advances. The later advance dates from the late Wisconsin; the age of the earlier was not determined. A variety of landforms was formed during the advance and retreat of the second glacier. Most were produced by live-ice deposition, but some are the result of local ice stagnation. The several levels of terraces which exist at elevations between 18 and 175 feet above the floodplain were carved up to approximately 9,000 B.P. The lower terraces have been cut since that date. — Author's abstract

02738 **Meeves, Henry C.; Darnell, Richard P.** Silver potential and economic aspects of the Leadville district, Lake County, Colo.: U.S. Bur. Mines Inf. Circ. 8464, 105 p., illus., tables, 1970.

A potential resource of silver estimated to be about 26 million ounces is contained mainly in reserves of lead and zinc ore and subordinately in low-grade manganese-bearing rock in the Leadville district, Colo. Part of these reserves is adjacent to abandoned mine workings and part is in unexplored ground. Geology and history of the district summarized from published sources form a background for outlining the problems of ore distribution; control of ground water affects the economics of mining the principal metals and accompanying silver. — APB

Meidav, Tsvi. *See* Snow, D. T. 02433

02903 **Meier, M. F.** Evaluation of South Cascade Glacier Test Site results, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 20-1—20-17, illus., tables [1970].

Various missions for remote sensing of snow and ice were flown at the South Cascade Glacier Test Site, Washington, which has many conditions similar to those encountered in the Arctic and Antarctic. Results of various imagery techniques are summarized in a table and evaluated; the passive microwave technique is considered the most promising of existing techniques for this purpose. Color IR film is the most useful for photography. However, insufficient data are available to provide firm conclusions on the usefulness of the important microwave or IR sensors. Recommendations for future missions are made. — EH

02308 **Merriam, Richard; Rieke, Herman H., 3d; Kim, Young C.** Tensile strength related to mineralogy and texture of some granitic rocks: Eng. Geology, v. 4, no. 2, p. 155-160, illus., tables, 1970.

The tensile strengths of a variety of granitic rocks from California were found to be inversely proportional to quartz content. This relationship is attributed to textural differences as suggested by high-quartz rocks composed of equidimensional grains showing little crystal intergrowth, or interlocking, whereas low-quartz rocks consist of interlocking laths and prisms. — Authors' abstract

02497 **Meszoely, Charles A. M.** North American fossil anguid lizards: Harvard Univ. Mus. Comp. Zoology Bull., v. 139, no. 2, p. 87-150, illus., tables, 1970.

A survey of osteological and epidermal scalation characters of extant lizards indicates that Recent species fall into three subfamilies: Gerrhonotinae, Anguinae, and Diploglossinae. The frontal bones and body osteoscutes, premaxillary foramen, and the postorbital in the orbit formation are the chief characters used to separate the species. Anguids first occur in the Cretaceous of Wyoming and Montana. Fragments from the Cretaceous Hell Creek Formation and late Paleocene Bison Basin sediments indicate that this lizard is referable to *Pancelosaurus*, n.gen.; the large Eocene and Oligocene fossils may have been derived from the Cretaceous *Pancelosaurus* or its relatives. The glyptosaurines represent a sideline of anguid evolution rather than being ancestors of modern forms. — *from* Author's abstract

02339 **Meyer, Richard F.** Geologic provinces code map for computer use: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1301-1305, 1970.

A code map of geologic provinces of the United States has been prepared for use in plotting petroleum production data by computer techniques. — WCC

02344 **Meyer, Willis G.** Carleton D. Speed, Jr. (1903-1970): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1310-1311, portrait, 1970.

Meyn, H. D. *See* McIlwaine, W. H. 02508

Meyn, H. D. *See* McIlwaine, W. H. 02509

02656 **Michaelis, E. R.** Sedimentologic models for Cardium of south-central Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 860, 1970.

02657 **Middleton, Gerard V.; Neal, William J.** Bed thickness in experimental turbidites [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 860, 1970.

02515 **Middleton, R.** (compiler). Robb Township, District of Cochrane: Ontario Dept. Mines Prelim. Geol. Map P. 598 (Geophys. Ser.), scale 1 in. to 1/4 mi., text, 1970.

The magnetic survey has indicated there are low magnetic susceptibility phases in the Kamiskota gabbro, and mafic and felsic volcanic rocks often have similar magnetic susceptibility. Bedrock, with the exception of diabase dikes, is composed of a related Archean intrusive-extrusive complex of gabbro, granitic rocks, and mafic and felsic volcanics. Volcanics are possibly isoclinally folded; three major fault trends have been indicated. The Kam-Kotia mine produces copper, zinc, silver, and gold. Faults, impervious contacts, and porous agglomerates make good exploration targets for nonferrous base metal deposits; highly magnetic areas in the gabbro may indicate concentrations of ilmenite; there may be porphyry ores in the quartz porphyries; and a long magnetic anomaly may be due to pyrrhotite mineralization. — MCM

02658 **Miller, Daniel N., Jr.** Integrated exploration economics in Wyoming, viewpoint of geologist [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 860-861, 1970.

Miller, Donald S. *See* Schroeder, Johannes H. 02678

Miller, Lee D. *See* White, Donald E. 03002

02899 **Milligan, V.; Lo, K. Y.** Observations on some basal failures in sheeted excavations [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 136-144, illus., table, 1970.

In excavations below ground-water level instability of the base may result from inflow of water into the excavation. The most important factors influencing the stability are the ground water and detailed soil conditions at the site. Construction problems encountered in excavations in clay strata underlain by pervious water-bearing layers are described. Remedial measures are also discussed. From a study of observations made in the case records, it is suggested that excavations in intact clays may be carried out to depths exceeding that limited by the ratio of $\theta/h = 0.5$, where θ is the distance from the bottom of the excavation to the top of the water-bearing stratum, and h is the water head at the top of the stratum, provided that the clay is not disturbed during construction so that the shear strength of the clay is preserved. – Author's abstract

Mills, D. H. *See* Palonen, P. 02514

Mitchell, James. *See* Dilcher, David L. 02876

02894 **Mitchell, R. J.; Crawford, C. B.** Anisotropic consolidation of Leda Clay — Discussion [of paper by L. K. Walker and G. P. Raymond, 1969]: Canadian Geotech. Jour., v. 7, no. 1, p. 92, 1970.

The paper under discussion was published, *in* ibid., v. 6, no. 3, p. 271-286, 1969; *see* Abstracts of North American Geology for May 1970. — GDC

02727 **Mitchell, Richard S.; Zulkiewicz, Rudolph J.** Virginia metamict minerals — Pyrochlore-microlite series: Southeastern Geology, v. 11, no. 3, p. 173-185, tables, 1970.

In Amelia County, Virginia, members of the Champion and Rutherford series pegmatites have about equal amounts of Ta and Nb, whereas a Morefield pegmatite has Ta > Nb and abnormally high Pb, U, Th, and TCe. A good correlation between chemical composition, degree of metamictization, and unit cell size was not found. Metamict specimens recrystallize between 400° and 500°C. Heat-treated samples are essentially pure pyrochlore-microlite through 700°C. A hexagonal $Ca(Ta,Nb)_4O_{11}$ phase appears at 800° but disappears before 1000°C. Orthorhombic $Ca(Ta,Nb)_2O_6$ and a phase close to cubic $(Ta,Nb)O_2F$ develop between 900° and 1000°C. In Morefield specimens a tetragonal $(Ta,Nb)O_2$ phase forms at 900°C and above. Specimens from Amelia, Powhatan, and Prince Edward Counties are described. — *from* Authors' abstract

02837 **Mitchell, Steven W.** Stratigraphy of the Hay River Formation, Upper Devonian, Northwest Territories, Canada: Michigan Academician, v. 2, no. 3, p. 103-132, illus., tables, 1970.

The Hay River Formation consists of 1,350 feet of interbedded shales, siltstones, sandstones, and some limestone and dolomite, outcropping at the west end of Great Slave Lake. In this study, the relation between fossil assemblages and depositional environments is examined, and many new genera and higher taxa are reported for the first time from the Hay River. The tectonic setting is described, and the major features shown on sketch maps. The Hay River Formation is considered as including all sediments between the Slave Point Formation and the Alexandra Falls Limestone Member. Sections are included, and fauna and flora collected are listed and some illustrated. The lithofacies of each unit are included in this list and described. — ESL

Mitropol'kiy, O. Yu. *See* Bilyavs'kiy, G. O. 02555

02372 **Moiseyev, A. N.** Late serpentinite movements in the California Coast Ranges, new evidence and its implications: Geol. Soc. America Bull., v. 81, no. 6, p. 1721-1731, illus., 1970.

There are two types of serpentinite in the Coast Ranges: one, intrusive (nondetrital), is the most widespread; the other, detrital, is less widespread. Both exhibit extrusive features indicative of remobilization, and because of this many bodies of detrital serpentinite may have been overlooked. The study and recognition of both types has important implications for interpretation of Coast Range geology, in light of global tectonic concepts. Detrital serpentinites were probably deposited at the base of a middle Mesozoic continental source, perhaps in an oceanic trench, whereas intrusive serpentinites and overlying mafic rocks represent the basement upon which the Great Valley sequence was laid. The ultramafic-mafic assemblage may represent a remnant of oceanic crust or an ophiolite extrusion. — EHP

02545 **Mokma, D. L.; Syers, J. K.; Jackson, M. L.** Cation exchange capacity and weathering of muscovite macroflakes: Soil Sci. Soc. America Proc., v. 34, no. 1, p. 146-151, illus., table, 1970.

By radioisotopic techniques, a cation exchange capacity of 9×10^{-7} meq/cm^2 was measured of muscovite cleavage surfaces, with a sensitivity of 10^{-7} meq/ml. Electron micrographs showed that the muscovite surface had been etched and a sesquioxidic weathering product formed as a result of 35 salt treatments but the CEC did not change. — Soil brief

02900 **Mollard, J. D.** Photo-interpretation studies in the location of prairie groundwater supplies [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 127-135, table, 1970.

Most of the photo-interpretation studies applied to hydrogeological investigations carried out in the Prairie provinces of western Canada involved the search for commercial sources of ground water in southern Saskatchewan and Alberta. Per-

formance records cover the period from 1956 to 1969. Of the 203 requests for consulting assistance, about 90 percent resulted in the interpretation of hydrogeological environments displayed on conventional black-and-white aerial photography. Field data are available on 127 projects including 84 ground-water development investigations. Airphoto interpretation techniques proved helpful for about 7 out of 10 projects; roughly half of the studies involved finding 10 to 60 Imperial gpm, and the other half involved finding 60 to 2,000 Imperial gpm. The studies sometimes mapped the surficial and bedrock hydrogeology and located small ground-water supplies. — *from* Author's abstract

02721 **Moore, Carl A.** Energy fuels field course and workshop: Shale Shaker, v. 20, no. 9, p. 177, 1970.

An energy fuels field course and workshop was given by the School of Petroleum and Geological Engineering of the University of Oklahoma in August 1969 at Grand Junction, Colo., and the Atomic Energy Commission presented an industrial nuclear fuels workshop with lectures and fieldwork on uranium and thorium exploration. A week of study each was devoted to gilsonite, oil shales, peacetime uses of atomic energy, coal deposits and oil, with field trips to sites in Colorado and Utah. — EH

02659 **Moore, Clyde H., Jr.** Recent intertidal cements, their mineralogy, texture, and significance, Grand Cayman, British West Indies [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 861, 1970.

02870 **Moore, P. B.; Smith, J. V.** Crystal structure of β-Mg_2SiO_4 — Crystal-chemical and geophysical implications, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 166-177, illus., tables, 1970.

The crystal structure of β-Mg_2SiO_4 is based on cubic close packing of O atoms with Si atoms sharing pairs of adjacent tetrahedral sites yielding (Si_2O_7) groups, and with Mg atoms occupying octahedral sites. Close-packed structures are discussed in terms of topology and of the simple ionic packing model. — Authors' abstract

02853 **Moore, R. K.** Radar progress in the NASA Earth Resources Aircraft Program, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 50-1 — 50-51, illus. [1970].

The article cites the progress achieved between 1964 and 1968 by the NASA Earth Resources Aircraft Program which developed usage of the scatterometer, multipolarization radar imagery, and polychromatic radar; techniques and results are outlined. The radar scatterometer has been successful in providing gross resolutions such as measuring "sea truth," detecting polar ice, and differentiating certain geologic and vegetation units. Imaging radar, because of the importance of a spatial context for analysis, is a more important tool for the geoscientist than the scatterometer. Multifrequency imaging radar, preferably "polypanchromatic," which provides consistency of color to the imagery, combined with multiimage data processing, should provide important results in the future. — EH

Moore, Roosevelt. *See* Hickling, Nelson L. 02388

02458 **Moore, T. C., Jr.; Kulm, L. D.** A high-resolution sub-bottom profiling system for use in ocean basins: Jour. Marine Research, v. 28, no. 2, p. 271-280, illus., 1970.

A new high-frequency (3-5-kHz) sub-bottom profiling system is capable of relatively deep penetration into sedimentary deposits, with good resolution of thin reflecting layers. This system has been operated at cruising speeds up to 11 knots and gives up to 0.15 seconds of penetration. Profiler records made aboard the R.V. CAYUSE and R.V. ARGO indicate that this system is particularly useful for defining shallow structures and areas of outcrop and that it will undoubtedly be valuable in sedimentological and stratigraphic studies. Used in combination with a low-frequency profiling system, a good overall picture of the sediment and structure in ocean basins may be obtained. — Authors' abstract

02502 **Moran, Stephen R.; Clayton, Lee; Cvancara, A. M.** New sedimentological and paleontological evidence for history of Lake Agassiz, Snake Curve Section, Red Lake County, Minnesota [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 22, illus., 1970.

02660 **Morelock, Jack; Bryant, W. R.** Consolidation of marine carbonate mud [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 861, 1970.

02488 **Morgan, James P.** Deltas, a resumé: Jour. Geol. Education, v. 18, no. 3, p. 107-117, illus., tables, 1970.

A short history of deltaic studies and a summary of factors which influence delta formation and also delta cycles in elevating, stable, and subsiding areas are given. It is concluded that cyclic sedimentation that occurs in a subsiding area is especially significant because it reflects conditions under which deltaic sedimentary sequences are being added to the geologic record. As long as subsidence continues, deltaic deposits accumulate; therefore, the structural behavior of a sedimentary basin must be considered the primary factor in influencing deltaic sedimentation. — EH

02882 **Morgenstern, N. R.** Black shale heaving at Ottawa, Canada — Discussion [of paper by R. M. Quigley and R. W. Vogan, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 114-115, 1970.

Morgenstern discusses the formation of gypsum *in situ*, a process related to heaving in black shale, described by Quigley and Vogan (ibid., p. 106-112). — EH

02795 **Morin, Robert; Theyer, Fritz; Vincent, Edith.** Pleistocene climates in the Atlantic and Pacific Oceans, a reevaluated comparison based on deep-sea sediments: Science, v. 169, no. 3943, p. 365-366, illus., 1970.

Variations of the *Globorotalia menardii* complex in cores from the Indian Ocean can be interpreted as indicating climatic changes that are opposite to trends exhibited by the total planktonic fauna. The questionable value of correlations between different water masses based on a single species can be shown by *Neogloboquadrina dutertrei subcretacea* in cores obtained off the coast of California and Baja California. This information, in addition to previous correlations between Quaternary cores of the Atlantic and Pacific oceans, indicates that the Pleistocene history of the two oceans was parallel. — Authors' abstract

02913 **Morley, L. W.** (editor). Mining and groundwater geophysics, 1967 — Canadian Centennial Conf., Niagara Falls, Ontario, 1967, Proc.: Canada Geol. Survey Econ. Geology Rept. 26, 722 p., illus., tables, 1970.

More than 500 geophysicists and geologists, representing 51 countries, attended and contributed to this conference. The 58 papers (45 cited separately) are grouped into the following categories: state of the art; geophysics in geological mapping and development of mineral resources; base metals; ferrous, radioactive and other minerals; ground water; national geophysical facilities; and human resources. — MCM

02942 **Morley, L. W.** Regional geophysical mapping [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 249-258, illus., 1970.

The new role for exploration geophysics of providing information on regional geological setting of ore deposits will become increasingly important as the high signal-to-noise ratio anomalies caused by shallow ore deposits are exploited leaving only deeper and more elusive ones. The importance of identifying favorable regions by geophysical as well as geological and geochemical means cannot be overemphasized; gravity and magnetics show promise and seismology will be used also. The aeromagnetic map of Canada, an example of advantages of regional geophysical interpretation, indicates tectonic styles and boundaries between major geologic provinces and delineates volcanic and metasedimentary belts where most mineral deposits are found. Advantage of such a map lies in its objectivity, its standard quality, and in con-

tinuity of several features which extend for 500 or 600 miles. — *from* Author's abstract

02558 **Moultrie, William.** Systems, computer simulation, and drainage basins: Illinois Geog. Soc. Bull., v. 12, no. 2, p. 29-35, illus., 1970.

The methodological background of computer simulation in geomorphology (both the conceptual basis of systems analysis and the operational concepts, such as deterministic and stochastic models) is reviewed. The Poplar Gap drainage basin in Kentucky, a closed system, is modeled by applying a gridded overlay to a quadrangle map; 106 control points were obtained. At each point the amount of removal of material is calculated on the basis of slope, depth of overland flow, and shear force. By reducing the elevations periodically at the control points over a simulated period of 6,000 years, no significant change was found in rates of change of the simulated basin development. Slope angle remained fairly constant through time. The relation of amount of erosion versus slope angle appeared to be linear and positively correlated. — EH

Mountjoy, Eric W. *See* Hopkins, John P. 02631

02661 **Mountjoy, Eric W.** Architecture of western part of Alberta basin and Upper Devonian reef trends [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 861-862, 1970.

02662 **Mountjoy, Eric W.** Comparison of some Alberta Upper Devonian reef complexes with modern Caribbean reefs [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 862, 1970.

02857 **Mueller, O. P.** Soil temperature regimes in a forested area of the northern Rockies: Soil Sci., v. 109, no. 1, p. 40-47, illus., 1970.

Soil temperatures for various depths up to 60 inches were measured at monthly intervals for one year on seven different soils. The soil temperatures were closely related to air temperatures and snow cover. Two sets of soil temperature relations, one showing warmer than air temperature and the other cooler than air temperature, are related to three soil groups. — JWH

02663 **Murray, R. C.** Dolomitization, dolomite distribution, reservoir rocks [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 862, 1970.

02718 **Murrell, S. A. F.; Digby, P. J.** The theory of brittle fracture initiation under triaxial stress conditions: Royal Astron. Soc. Geophys. Jour., v. 19, no. 4, p. 309-334, illus., table, 1970.

A calculation has been carried out of the conditions under which crack propagation is initiated in an isotropic, brittle solid of the Griffith type when the solid is subjected to a homogeneous, uniform but otherwise arbitrary triaxial system of stresses at infinity. The cracks have been taken to be flattened ellipsoidal cavities. The results are in broad agreement with results obtained in the two-dimensional treatment of the problem, and with experimental observations. Tensile and shear fracture is possible and the Mohr envelope is of parabolic form. Fracture initiation is shown to be independent of the intermediate principal stress. — Authors' abstract

Nadeau, Joseph. *See* Baars, D. L. 02584

Nance, W. B. *See* Martin, J. R. 02266

02264 **Nava, David F.** Atomic absorption and classical chemical analyses of the Lost City meteorite [abs.]: EOS, v. 51, no. 7, p. 580, 1970.

Neal, William J. *See* Middleton, Gerard V. 02657

02274 **Nease, Felton R.; Wolf, Frederick A.** Nonpetrified fossils in Pleistocene sediment from a marl quarry site in eastern North Carolina: Elisha Mitchell Sci. Soc. Jour., v. 86, no. 1, p. 41-43, 1970.

Pleistocene sediment from a marl quarry contains nonpetrified fossil wood, seed, leaves, pollen, ferns, mosses, liverworts, and parts of insects; these fossils are like living organisms in the area, and their occurrence shows that uninterrupted vegetational stability has been maintained from time of their deposition in fresh-water pools. The fossil-containing layer of Wisconsin sediment, exposed when the deeply lying deposits of Castle Hayne limestone was being uncovered, appears to be lacustrine. By carbon dating it has an age of 24,700 ± 700 yr; it is buried beneath a 10-12 ft layer of yellowish brown clay sand and is coal black and sticky; and the color is imparted by abundance of carbonized organic material. The inorganic component is mainly fine-grained sand but is admixed with clay. — *from* Authors' abstract

Nease, Felton R. *See* Wolf, Frederick A. 02275

02373 **Nehru, C. E.; Prinz, Martin.** Petrologic study of the Sierra Ancha sill complex, Arizona: Geol. Soc. America Bull., v. 81, no. 6, p. 1733-1765, illus., tables, 1970.

The complex, a major high-alumina basaltic intrusive of late Precambrian age in the central Arizona dolerite province, consists of three zones: lower dolerite, 200 feet; microtroctolite, 235 feet, upper dolerite, 275 feet. Dolerite zones crystallized from high-alumina basaltic magma and are taken to represent parent magma. This magma is similar to late Precambrian high-alumina basaltic magmas that crystallized anorthositic rocks but differs from orogenic high-alumina basalts and major layered intrusions. The three zones constitute separate and concordant sills. Microtroctolite is thought to have intruded as either a crystal mush or liquid that fractionated in magma chamber. The upper dolerite sill differentiated upward from high-alumina basalt to lower alumina basalt by crystallization and diffusion with overlying magma. — RAL

Nelen, J. *See* Clarke, R. S., Jr. 02265

02551 **Nelson, R. E.** Semimicro determination of sulfate in water extracts of soils: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 343-345, table, 1970.

Sulfate in water extracts of soils is precipitated in 2:1 acetone-water solution by adding excess $Ca(NO_3)_2$ and HNO_3 to the acid pH indicated by thymol blue. The precipitate is filtered and washed free of occluded ions by leaching with ethanol. The amount of sulfate is calculated from the Ca content (0.005-0.05 meq) in the precipitate, which is determined by EDTA titration. Since the procedure is simple and rapid, the method is suitable for routine soil analysis. — Author's abstract

Ness, A. O. *See* Parsons, R. B. 02568

02664 **Nestell, M. K.; Danner, W. R.** Cache Creek fusulinids from southern British Columbia [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 862, 1970.

Nettleton, W. D. *See* Gamble, E. E. 02548

02809 **Newnham, Ivan.** Dr. A. D. Wadsley, 1918-1969, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. VI-VIII, portrait, 1970.

Nichols, Rachel. *See* Matsumoto, Mayme. 02714

Nicholson, Alex. *See* Johnson, Kenneth S. 02494

02368 **Noble, James A.** Metal provinces of the western United States: Geol. Soc. America Bull., v. 81, no. 6, p. 1607-1624, tables, 1970.

By plotting the distribution of copper, gold, silver, lead and zinc, mercury, tungsten and molybdenum, the metal provinces of the United States west of the Great Plains are outlined. The individual provinces have distinctive, but similar shapes; they are only rarely rectangular. The author describes them as making "a crude raylike pattern around the Colorado Plateau, localized at four thick piles of Tertiary volcanic rocks." Provinces near the Pacific Coast can be related to tectonic features; those inland can not. Separation of deposits by age would have little effect on the pattern. The study area is anomalous in respect to thin crust, high heat flow, low gravity, and low P_n velocities in the upper mantle. The source of the metals is believed to be the mantle. — RGY

02358 **Nordlund, Reymond L.; Deere, Don U.** Collapse of Fargo grain elevator: Am. Soc. Civil Engineers Proc., v. 96, paper 7172, Jour. Soil Mechanics and Found. Div., no. SM2, p. 585-607, illus., tables, 1970.

The rate of application of the load and its magnitude at failure of the Fargo [North Dakota] grain elevator were known, also distribution of the load on the foundation; there were, however, some complicating factors. The subsoil [deposited in glacial Lake Aggassiz] consisted of four distinct layers within the significant depth: three were clay or silty clay while the fourth was an interbedded sand, silt and clay. In addition it was shown that shear strength varied greatly depending upon the method of testing. The observed bearing capacity was compared with various computed values depending upon the method of measuring shear strength. Results indicated that Skempton's solution gave excellent results if shear strengths measured by vane tests were used and the concept of progressive failure was utilized. — *from* ASCE abstract

Norquay, I. P. *See* Costello, J. T. 02933

02552 **Norvell, W. A.; Lindsay, W. L.** Lack of evidence for $ZnSiO_3$ in soils: Soil Sci. Soc. America Proc., v. 34, no. 2, p. 360-361, 1970.

The solubility constant for $ZnSiO_3$ reported in the literature is based on invalid thermodynamic data. The agreement between Zn^{2+} concentrations in some soils and the invalid solubility constant for $ZnSiO_3$ is coincidental. The presence of this compound in soils is very unlikely. — Authors' abstract

Nunan, J. P. *See* Farvolden, R. N. 02895

Nunzi, A. *See* Fanfani, L. 02990

02404 **Nur, A.; Simmons, G.** The origin of small cracks in igneous rocks: Internat. Jour. Rock Mechanics and Mining Sci., v. 7, no. 3, p. 307-314, illus., tables, 1970.

Available data for brittle rocks are used to evaluate the relative importance of the pressure and thermal history and mineralogic composition on crack density; mechanical effects of drilling cores from rocks under stress are examined also. These cracks are of importance in examining properties of igneous rocks at confining pressures below 1 or 2 kb in the laboratory, and it is important to determine whether cracks exist in the rocks *in situ* or whether they can be introduced upon removal of a sample from the earth. It is shown that difference in compressional velocities at 1 atm and 10 kb, a sensitive indicator of microcrack porosity, is related to presence of quartz in many igneous rocks. The origin of such cracks can be attributed to the relatively high values of thermal expansion and compressibility of the quartz; only a few cracks are induced by drilling stressed rocks. — VSN

02806 **Oakeshott, Gordon B.** Geology of the Yosemite Valley: Sci. and Children (Washington, D.C., Natl. Sci. Teachers Assoc.), v. 7, no. 6, p. 18-21, illus., 1970.

This popular account of Yosemite Valley discusses the rocks and landforms. Ten references are given for further reading. — MCM

02726 **Ocean Industry.** New tools for testing and analyzing ocean bottom: Ocean Industry, v. 5, no. 5, p. 39-40, illus., 1970.

Three *in situ* soil test devices developed by the Naval Civil Engineering Laboratory and capable of working in water at depths to 6,000 feet are described. The Deep Ocean Test Instrument Placement and Observation System (DOTIPOS) is a bottom-sitting platform, designed as a monitoring and control system; its vane shear accessory and other devices measure soil strength and type, perform cone-penetration tests and 10-ft sediment coring. A plate-bearing device measures soil properties influencing short-term behavior of footing-type foundations. The Long-term Ocean Bottom Settlement Test for Engineering Research (LOBSTER) is designed to be deployed by DOTIPOS on the ocean floor to study footing foundation behavior. Data are collected on its total and differential settlement. The foundation monitor, soil sampling, and other devices are also under development. — EH

Odegard, Mark E. *See* Sutton, George H. 02779

02289 **Odekirk, J. R.** Desert Mountain granite, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 33, 1970.

Desert Mountain, at the extreme southern end of the Sheeprock Mountains, is composed of a dark Precambrian(?) complex overlain by Precambrian(?) quartzite and Ordovician(?) dolomite, all intruded by leucogranite. Tertiary rhyolite and ignimbrite cover the east side of the mountain and overlap the Precambrian complex and granite. Pb-α ages for zircon of 36 m.y. for the leucogranite and 41 m.y. for the hornblende-biotite granite indicate an Eocene age seems reasonable for the Desert Mountain granite. — MCM

02665 **Oldaker, Richard B.** Evaluation of petroleum prospects under conditions of uncertainty [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 862-863, 1970.

03010 **Oliver, H. W.** Geophysical studies, *in* Mineral resources of the Emigrant Basin primitive area, California: U.S. Geol. Survey Bull. 1261-G, p. G44-G49, tables, 1970.

The aeromagnetic survey of the Emigrant Basin primitive area was flown along a series of east-west profiles; the total magnetic intensity ranges from about 2,000 gammas in the southwest section to about 2,550 gammas just northwest of Emigrant Lake and near Leavitt Peak, Relief Peak, and High Emigrant Lake; total magnetic relief is less than 600 gammas. Sharpness of magnetic anomalies increasing with elevation of land surface suggests the anomalies are probably caused by magnetic rocks exposed at the surface. There is no magnetic evidence for large concealed bodies of tungsten-bearing tactite along margins of roof pendants; there are no commercial iron deposits or serpentinite bodies that serve as guides to gold and silver lodes; and there is no indication of strongly magnetic placers. — MCM

02666 **Oliver, William B.** Geologist's role in evaluation economics [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 863, 1970.

02888 **Olpinski, K.** Hydrogeologic aspects of dewatering at Welland — Discussion [of paper by R. N. Farvolden and J. F. Nunan, 1970]; Theoretical analysis of aquifer response to dewatering at Welland — Discussion [of paper by E. O. Frind, 1970]: Canadian Geotech. Jour., v. 7, no. 2, p. 217-218, 1970.

Olpinski refers to papers by Farvolden and Nunan (ibid., p. 194-214) and Frind (ibid., p. 205-216) and discusses methods and results of dewatering certain sites for channel excavation contracts for the Welland Channel Relocation project. — EH

02426 **Olson, Richard H.** Some factors to consider in evaluating talc deposits [abs.]: Mining Eng., v. 22, no. 1, p. 41, 1970.

Ong, Patricia T. *See* Tackett, Stanford L. 02960

02880 **Ongley, E. D.** Drainage basin axial and shape parameters from moment measures [with French abs., p. 89]: Canadian Geographer, v. 14, no. 1, p. 38-44, illus., table, 1970.

Existing indices of drainage basin shape, symmetry and axial properties are operationally limited by subjectivity of inherent inadequacies. Drainage basins, recognized as a function of contained networks, are better described by moment measures derived from network characteristics. By joining all sources (pendant vertices) to the mouth, a network may be reduced to a frequency distribution. The normal approximation to circular data appears to be satisfactory for real networks. Descriptive statistics provide direct measures of drainage network shape, symmetry and axial properties. — Author's abstract

02931 **Oostdam, B. L.** Exploration for marine placer deposits of diamonds [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 447-461, illus., tables, 1970.

Marine placer deposits are localized concentrations of transported heavy minerals generally restricted to inner continental shelves off mineralized areas such as ancient shields. Economical exploration consists of planned sampling traverses utilizing indirect geophysical methods followed by direct sampling in selected areas. Continuous acoustic profiling has been most successful in outlining sediment bodies of thickness suitable for mining purposes and in locating ancient strandlines, topographic traps, and promising gravel patches. High definition profilers are preferred to those giving deep penetration because only limited thicknesses of sediments can be mined at a profit. On account of the extremely patchy distribution of precious minerals, precise navigation is of great importance for exact relocation. Selected geophysical methods, surveying systems, and illustrated case histories are discussed briefly. — *from* Author's abstract

02318 **Oriel, Steven S.; Tracey, Joshua I., Jr.** Uppermost Cretaceous and Tertiary stratigraphy of Fossil basin, southwestern Wyoming: U.S. Geol. Survey Prof. Paper 635, 53 p., illus., tables, 1970.

More than 7,000 feet of uppermost Cretaceous and Tertiary continental strata in the northern part of Fossil basin, along the southern part of the western Wyoming thrust belt, are subdivided into 15 new members of the Evanston (3), Wasatch (7), Green River (2), and Fowkes (3) Formations. Recognition of these new units makes genetic reinterpretations possible. Moreover, stratigraphic and geometric relations establish that the Fossil basin, which began sinking in latest Cretaceous time and continued to sink well into the Eocene, was a region of moderate relief then. Major movements along thrust faults from the Absaroka fault westward had ended by latest Cretaceous time. Mainly rhyolitic volcanism is recorded for the region in middle to late Eocene time. — SSO

Oró, J. *See* Levy, Ram L. 02737

Ouimet, J. M. *See* Dussault, R. 02890

Overbey, W. K., Jr. *See* Rough, R. L. 02739

02667 **Overton, Harold L.** Salinity variations and anomalies in marine sandstone [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 863, 1970.

02369 **Oxburgh, E. R.; Turcotte, D. L.** Thermal structure of island arcs: Geol. Soc. America Bull., v. 81, no. 6, p. 1665-1688, illus., 1970.

The ocean-floor spreading hypothesis requires that island arc areas be loci of descending mass transport and destruction of oceanic crust. All island arc areas are characterized by volcanic activity and in some, unusually high heat flow values have been measured for hundreds of kilometers behind the arc. Downward mass motion is associated presumably with the sinking of cool and thus relatively denser matter, and high temperature phenomena normally would not be expected where this was occurring. The only feasible means of generating heat in such areas appears to be by frictional dissipation along the seismically active zone of movement (the Benioff zone) between the moving oceanic crust and upper mantle, and the relatively stationary material that it underrides. — *from* Author's abstract

02531 **Pabian, Roger K.** Gemstone occurrences in Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 35-36, 1970.

02532 **Pabian, Roger K.** A theoretical ontogeny of the Pennsylvanian trilobite *Ditomopyge scitula* (Meek and Worthen) [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 36, 1970.

02533 **Pabian, Roger K.; Strimple, Harrell, L.** Paleoecology of Pennsylvanian crinoids from southeastern Nebraska and southwestern Iowa [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 36, 1970.

Pablo Galán, Liberto de. *See* Schlaepfer, Carmen J. 02676

02668 **Pallister, A. E.** Operation Arcticquest, application of multidiscipline, multiparticipant exploration concept [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 863, 1970.

02454 **Palmer, Katherine V. W.** Paleozoic nonmarine bivalve from a deep well in Georgia: Georgia Acad. Sci. Bull., v. 28, no. 1, p. 45-54, illus., 1970.

Specimens of a fossil pelecypod from a core of a deep well, 6995-7015 feet, in Early County, Georgia, are determined as the nonmarine freshwater *Anthraconauta* and compared to *A. phillipsii* (Williamson) s.l. from the British Upper Carboniferous, from the Pictou Group of Nova Scotia, and from the Pottsville Series, Pennsylvanian, of Ohio. Even in the restricted field of the size of the core, several small specimens occur together in close association resembling a habitat similar to those in the zones of the Carboniferous. Associated with the bivalves are ostracods identified by Swartz as Late Ordovician or Early Silurian. — *from* Author's summary

02514 **Palonen, P.; Mills, D. H.** Whitefish Lake Indian Reserve No. 6, Louise-Eden area, District of Sudbury: Ontario Dept. Mines Prelim. Geol. Map P. 597, scale 1 in. to 1/4 mi., text, 1970.

Much of the Whitefish Lake Indian Reserve was the site of a major Pleistocene drainage channel which flowed southwest between the Vermilion and Whitefish Rivers; considerable deposits of coarse gravel commonly occur on the southwest side of resistant outcrops of gabbro and quartzite. Outcropping sediments probably belong to the Hough Lake and Quirke Lake Groups of the Huronian Supergroup. Four types of intrusive rocks cut through the metasediments; late olivine diabase dikes intrude all other rocks. Two major folds and two fold sets with axes plunging southwest are cut by several fault sets of different orientations. Limited exploration has been conducted for copper, nickel, and gold, but no deposits of commercial importance have been found. — MCM

02300 **Pampe, William R.** Stratigraphy of the Devonian rocks of western Colorado: Earth Sci. Bull., v. 3, no. 1, p. 19-43, illus., table, 1970.

Devonian rocks of western Colorado, exposed on the White River Uplift, the Sawatch Range and the San Juan Mountains, consist of a lower clastic unit, the McCracken, Elbert and Parting Formations, and an upper carbonate unit, the Dyer and Ouray Formations. The Devonian unconformably overlies Ordovician beds on the White River Uplift and the Sawatch Range and Cambrian rocks on the San Juan Mountains. In west-central Colorado the Parting Formation is correlative with the Elbert Formation of the San Juan Mountains, on whose southern flank it overlies the McCracken Formation. The Dyer Formation in this area and the Ouray in southwestern Colorado are correlative and comprise the upper carbonate sequence. In southwestern Colorado the Mississippian Leadville Formation overlies the Ouray conformably. The upper Ouray and the lower Leadville are lithologically similar. On much of the Sawatch Range and the White River Uplift the Gilman Formation overlies the Dyer Formation. — *from* Author's abstract

02804 **Pampe, William R.** Nature's hot water heaters: Sci. and Children (Washington, D.C., Natl. Sci. Teachers Assoc.), v. 7, no. 6, p. 32-33, illus., 1970.

This popular account describes geyers, hot springs, mud pots, mud volcanoes, and fumaroles. – MCM

02710 **Pan, Cheh.** The gravitational factor from mid-continental body tides and its statistical analysis: Tectonophysics, v. 9, no. 1, p. 15-46, illus., tables, 1970.

A total of 99 days of data selected from a period of five months of tidal variations of gravity recorded at St. Louis University, St. Louis, Mo., are utilized in determination of the gravitational factor $G = 1 + h - 3k/2$; influence of oceanic tides in this midcontinent location is negligible. The mean G-value thus determined is 1.144 ± 0.006, generally lower than those previously determined in coastal areas. Statistical techniques are applied in the data processing in order to obtain statistically more reliable values, and an error analysis is then performed to check reliability. A combination of cross-correlation, bandpass filtering, and auto-correlation techniques are effective in elimination of errors. — *from* Author's abstract

Panek, Louis A. *See* Wang, Fun-Den. 02439

Parasnis, D. S. *See* Mabey, D. 02941

Pariseau, William. *See* Voight, Barry. 02361

02283 **Park, G. M.** Granite Mountain, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 21, 1970.

Granite Mountain, an isolated relatively small mass in the Dugway Proving Ground in Tooele County, consists almost entirely of leucogranite, porphyritic leucogranite and coarse-grained biotite-granite gneiss, intruded by many pegmatites. Using the K-Ar method, an age of 30 ± 2 m.y. for muscovite from a beryl-bearing pegmatite intruding gneiss was determined. — MCM

02284 **Park, G. M.** Volcanics, Thomas Range, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 23, 1970.

The Thomas Range in Juab County consists primarily of rhyolitic flows and tuffs. In 1959 a lead-alpha age of 20 m.y. was obtained for zircon from welded rhyolitic crystal tuff on the west side of the range. A more recent K-Ar determination is 16.2 ± 1.5 m.y. for sanidine from the upper Topaz Mountain rhyolite which overlies the beryllium-bearing tuff. If the Pb-α age is correct, both older and younger groups of volcanics are of Miocene age; the beryllium mineralization is therefore Miocene or younger. — MCM

Park, J. *See* Brooke, J. 03009

02384 **Parker, Dale E.; Lee, Gerhard B.; Yanggen, Douglas A.** Using soil maps to delineate floodplains in a glaciated low-relief landscape: Jour. Soil and Water Conserv., v. 25, no. 3, p. 96-99, illus., tables, 1970.

Floodplain boundaries determined by engineering methods were superimposed on detailed soil maps along two reaches of the Root River watershed in southeastern Wisconsin. A comparison of the predicted flood boundaries with soil boundaries showed that alluvial soils are subject to frequent flooding. In addition, other soils adjacent to or connected with the alluvial bottomlands were susceptible to flooding in varying degrees. The most poorly drained soils were, in general, the most likely to flood. — Authors' abstract

02573 **Parker, Jack.** Temperature and humidity affect strength of rock structures at White Pine: Soc. Mining Engineers AIME Trans., v. 247, no. 2, p. 142-144, illus., 1970.

At the White Pine copper mine in Ontonagon County, Mich., a rock mechanics program was set up in 1963 to promote safety and mining efficiency. An annual cycle of rock deterioration is caused by the annual temperature-humidity cycle at the surface. In order to control changes of rock moisture content to maintain stability of the rock, attempts are being made to control air temperature in the mine so as to avoid condensation and also to seal the rock in critical areas. — EH

02799 **Parker, Travis J.** Regional structure of the southeast Texas coastal plain, *in* Outcrops of the Claiborne Group in the Brazos Valley, southeast Texas — Geol. Soc. America South-Central Sec., 4th Ann. Mtg., 1970, Guidebook: [College Station, Tex.] Texas A and M Univ., Dept. Geology, p. 4-11, illus., 1970.

The author describes the structure of the southeast coastal plain very generally and includes geologic and structure sketch maps. The region is part of a homocline dipping gently southeastward at rates ranging from about 80-200 feet per mile. Most of the Tertiary shale units and some sandstones thicken gradually toward the southeast and the dip of any individual stratigraphic horizon increases in that direction. The Mexia-Talco zone of normal faults crosses the northwestern part of the area and complex grabens are also formed. There are probably unlocated faults in that region. Four salt domes are located and detailed structure maps of two are included. — EH

02568 **Parsons, R. B.; Balster, C. A.; Ness, A. O.** Soil development and geomorphic surfaces, Willamette Valley, Oregon: Soil Sci. Soc. America Proc., v. 34, no. 3, p. 485-491, illus., tables, 1970.

Haploxerolls, Argixerolls, Haploxeralfs, and Haplohumults occur on a sequence of geomorphic surfaces mapped for about 7,800 km² of the Willamette Valley. Radiocarbon dates provide ages for some of the recent geomorphic surfaces and soil properties such as organic matter accumulation, B and Bt horizon development, and base distribution. — Soil brief

02955 **Parsons, R. B.; Herriman, R. C.** Haploxerolls and argixerolls developed in recent alluvium, southern Willamette Valley, Oregon: Soil Sci., v. 109, no. 5, p. 299-309, illus., tables, 1970.

Study of soils and geomorphology along the Willamette River indicates a sequence of increasingly developed soils on successively older geomorphic surfaces. Soils of the Winkle surface have been dated at 5,250 ± 270 years, and soils in Ingram surface have to be dated at 555 ± 100 years. Soils on the Ingram surface are subject to periodic floods, the Winkle surface is usually not flooded. The flooding factor is important in land use planning. — JWH

02364 **Parsons, Willard H.** Cerro Negro Volcano: Explorer, v. 12, no. 2, p. 16-19, illus., 1970.

Cerro Negro, the most active volcano in Nicaragua, is reported to have erupted first in 1850, near the flank of the Las Pilas volcanic cluster; subsequent eruptions have built a main cinder cone about 800 feet high. First activity of the October 23, 1968, eruption was from fractures at the base of the main cone where two lava fountains broke out about 500 feet south of the base of the main cone; eventually the two centers coalesced. On the second day explosive activity began at the main crater and within a few days continuous ash clouds were shot to 5,000 feet above the cone. The eruption reached its climax December 2 and ceased December 10. A great deal of the cotton crop was damaged, farms within ten miles downwind were ruined, and the city of Leon 20 miles away had ash-covered streets and buildings. The lava flow is a characteristic vesicular basalt composed mainly of feldspar and pyroxene crystals with a few grains of olivine in a black matrix. Indications are that Cerro Negro is a growing young volcano. — MCM

02945 **Paterson, Norman R.** Exploration for massive sulphides in the Canadian Shield [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 275-287, illus., tables; discussion, p. 287-289, 1970.

The physical environment of the Canadian Shield is such that EM and gravity methods are well suited to the exploration for massive sulphides. A number of instrumental systems and survey methods, both airborne and ground, have evolved to meet the particular requirements of the area. The choice of primary method or combination of methods depends principally on location and local environment. Follow-up methods usually consider the nature of the orebody sought. Specific exploration programs, both regional and local, show examples of the successful application of geophysics in the Canadian Shield. — Author's abstract

Patriquin, David. *See* Smith, Donald L. 02684

02414 **Paulding, Bartlett W., Jr.** Coefficient of friction of natural rock surfaces: Am. Soc. Civil Engineers Proc., v. 96, paper 7121, Jour. Soil Mechanics and Found. Div., no. SM2, p. 385-394, illus., tables, 1970.

Although coefficients of friction of rock on rock have been measured in the laboratory, the use of such values in rock slope analyses is limited because of uncertainties associated with attempting to account for the extrapolation from laboratory-size samples to dimensions of geologic interest. The coefficient of friction of natural rock surfaces can be determined by analyses of the orientation of surfaces along which gravity sliding takes place. When sliding occurs simultaneously along two planes, leaving a V-shaped notch, calculation of the coefficient of friction is facilitated by means of the stereographic projection. Measurements obtained from slopes where sliding has occurred yield the upper limit of the coefficient of friction. Unique values of the coefficient are obtained by monitoring the motion of blocks which experience quasi-stable or intermittent sliding and noting the orientation of the contacting surfaces. — ASCE abstract

02907 **Paulson, Richard W.** Estuarine studies, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 24-1 — 24-10, illus. [1970].

Objectives of the U.S. Geological Survey's Delaware Estuary Program are to determine whether variations in water quality, known to exist in this water body, can be detected remotely and to devise ways of using remote-sensing data to solve estuarine problems. Evaluation of data from missions flown in the estuary in 1967 and 1968 showed that thermal variations as small as 1°C and spatial variations as small as 100 feet can be detected by infrared (IR) imagery as well as larger phenomena which have greater contrasts. Color IR photography was superior to color photography for detecting sediments and chemical pollutants. Imagery revealed fine-grained thermal structures possibly caused by mixing of estuarine and tributary flows, wind stress and thermal effluent. Potential applications of remote-sensing methods to estuarine studies include estuarine circulation, dispersion, and aeration. — EH

Pavlick, Raphael J. *See* Dilcher, David L. 02876

Pawson, D. L. *See* Donnay, G. 02236

02477 **Pedersen, K. Raunsgaard; Lam, Jörgen.** Precambrian organic compounds from the Ketilidian of South-West Greenland, Pt. 3: Medd. Grönland, v. 185, no. 7, 42 p., illus., tables, 1970; *reprinted as* Grönlands Geol. Undersögelse Bull. 82, 1970.

Ketilidian sedimentary rocks nearly 2,000 m.y. old and only slightly metamorphosed contain fossils and organic compounds. Results of work on organic material from a 1-3 m thick coal-graphite layer from the Foselv Formation in the Sortis Group in Graenseland are presented. Aliphatic hydrocarbons are dominant in the extract from two coal-graphite samples. These compounds have many saturated straight-chain hydrocarbons, with the n-C-15 alkane, ranging from C-12 to about C-21, and various isoalkanes and anteisoalkanes. Saturated cyclic hydrocarbons like alkyl cyclohexanes, and homologous series of alkyl benzenes and naphthalenes are also present, as are monoterpenoid compounds, six of which are fairly well characterized by their mass spectra. Fatty acids and methyl esters of fatty acids are present, notably a homologous series of straight-chain fatty acids. Branched acids are present in minor amounts. — *from* Author's abstract

02930 **Pemberton, R. H.** Airborne radiometric surveying for mineral deposits [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 416-424, illus., tables, 1970.

Primary targets of recent airborne radioactive surveying in Canada and the United States are Triassic-Eocene epigenetic peneconcordant uranium deposits in western U.S., Precambrian pitchblende-bearing vein deposits of Beaverlodge type, Proterozoic conglomerate ores of Blind River type, and pegmatitic occurrences such as the Bancroft deposits. Optimum radiometric instrumentation should be designed around the U:Th ratio of each type of ore occurrence being sought as well as radioactive elements associated with nearby formations of host rocks. Practical field procedures are discussed and radiometric profiles over a wide variety of different radioactive mineral occurrences and rock types are presented. No accurate quantitative evaluation of U, Th, or K content associated with any radiometric anomaly can be made from airborne data regardless of sophistication of instrumentation employed. Practical aspects of interpretation and full potential and limitations of the method for economic minerals are discussed. — *from* Author's abstract

02889 **Penner, E.** Frost heaving forces in Leda clay [with French abs.]: Canadian Geotech. Jour., v. 7, no. 1, p. 8-16, illus., 1970.

The frost heaving forces developed under a 1-ft (30.5 cm) diameter steel plate were measured in the field throughout one winter. The plate was fixed at the ground surface with a rock-anchored reaction frame. Heave gauges and thermocouples were installed at various depths to determine the position and temperature of the active heaving zone. The general trend was for the surface to increase as the winter progressed. When the frostline approached maximum depth the force was in excess of 30,000 lb (13,608 kg). Estimates of the heaving pressure at the frostline ranged from 7 to 12 psi (0.49 to 0.84 kg/cm^2) during this period. The variation of surface heaving force was closely associated with weather conditions. Warming trends resulting in a temperature increase of the frozen layer caused the forces to decline. — Author's abstract

02844 **Peplies, Robert W.** Land use and regional analysis, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 5-1 — 5-16, illus., tables [1970].

This study of the value of remote sensing in determining land-use features and for regional land-use and transportation planning was made by the Geography Department of East Tennessee State University in the drainage basin of the upper French Broad River in the Asheville Basin of western North Carolina in 1965. Evaluations of the performance of various types of conventional and infrared film and radar imagery for interpreting various land-use features and for landscape analysis are given. Results of the study were compared with those of a conventional study by a consultant firm, made of the same area at the same time. Remote-sensing identification was found to be more accurate and was cheaper. Future applications of this type of survey to the coordinated land-use mapping program of the United States are outlined. — EH

02466 **Peppers, Russel A.** Correlation and palynology of coals in the Carbondale and Spoon Formations (Pennsylvanian) of the northeastern part of the Illinois basin: Illinois Geol. Survey Bull. 93, 173 p., illus., table, 1970.

Spores have been used to identify coals which heretofore had not been adequately correlated. Various names are abandoned as the coals have become correlated with established coal beds elsewhere, and some new coal beds are identified. Of the 59 genera and 221 species identified, 4 genera and 35 species are new and are described and illustrated. The various coals were distinguished and correlated by the distribution and relative abundance of the spore taxa. *Lycospora* is by far the most abundant genus in the Carbondale and upper Spoon coals except in the interval which includes the Lowell no. 4 and no. 5 coals. *Thymospora pseudotheisseni* is significant between no. 4 and no. 5A coals and *Anapiculatisporites spinosus* characterizes coals no. 4 and no. 5. Others are also distinctive. — HRC

Perkins, Alfred J. *See* Grove, E. L. 02877

Perkins, Bob F. *See* Erdogan, Solmaz Z. 02614

02669 **Perkins, Bob F.** Genetic implications of rudist reef architecture [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 863-864, 1970.

Perkins, R. D. *See* Friedman, M. 02401

Perkins, R. W. *See* Rancitelli, L. A. 02272

02965 **Persiani, C.; Cosgrove, J. F.** The determination of thorium in rare earths by gamma-ray spectrometry: Appl. Spectroscopy, v. 24, no. 2, p. 250-252, illus., tables, 1970.

A method for the radiometric nondestructive determination of thorium in rare earths using multichannel gamma-ray spectrometry is described. Radioactive secular equilibrium is discussed relative to the method. Results obtained are compared to other analytical techniques. — Authors' abstract

02995 **Peterson, G. L.; Gastil, R. G.; Allison, E. C.** Geology of the Peninsular Ranges: California Div. Mines and Geology Mineral Inf. Service, v. 23, no. 6, p. 124-127, illus., 1970.

In the Peninsular Ranges province, ages of oldest rocks are poorly documented, but late Paleozoic and early Mesozoic fossils have been reported, and Jurassic fossils are present locally in the western part. In mid-Cretaceous, the sedimentary and volcanic rocks were complexly metamorphosed and invaded by the Southern California batholith, whose rocks are the dominant terrane. Low-grade ores are associated with batholithic and pre-batholithic rocks; recent activity is in production of crushed, broken, and dimension stone. Post-batholithic rocks are confined mainly to the coastal area where construction materials and minor amounts of placer gold have been extracted. The province appears to be an uplifted and westward-tilted block, cut by numerous, large, NW-trending faults, the largest parallel to the San Andreas system and probably closely related. Marine terraces are abundant in some tectonically active areas. — MCM

Peterson, M. N. A. *See* Karig, D. E. 02330

02773 **Peterson, Norman V.; McIntyre, James R.** The reconnaissance geology and mineral resources of eastern Klamath County and western Lake County, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 66, 70 p., illus., tables, geol. map, 1970.

The 6,000 sq mi area is underlain by a thick assemblage of Oligocene to Holocene volcanic rocks and derived sedimentary deposits; oldest rocks (pyroclastics) occur in the eastern third, younger (mainly basaltic) in the western and northern parts. Most conspicuous structural features are N to NW-trending normal faults; after this fault pattern was initiated, the area was folded into broad, low-amplitude anticlines and synclines. Quaternary events include volcanic eruptions resulting in maars and pumice from Mt. Mazama eruption. Mineral resources typical of a Cenozoic volcanic region are abundant and widespread; hot springs, hot-water wells, and large areas of anomalously high heat flow indicate possibilities of geothermal energy. Mineral resources include copper, lead, zinc, silver, uranium, mercury, diatomite, pumice, perlite, peat, and building materials. — *from* Authors' abstract

Peterson, Warren L. *See* Kepferle, Roy C. 02640

02783 **Petracca, A. N.** Tertiary microfauna, Mackenzie Delta area [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 864, 1970.

03014 **Petryk, A. A.; Mamet, B. L.; Macqueen, R. W.** Preliminary foraminiferal zonation, Rundle Group and uppermost Banff Formation (Lower Carboniferous), southwestern Alberta: Bull. Canadian Petroleum Geology, v. 18, no. 1, p. 84-103, illus., 1970.

Foraminifera permit recognition of Zones 7 to 16 of a scheme derived initially from European Carboniferous rocks. Vertical variations in foraminiferal families are similar to familial variations in Lower Carboniferous platform rocks in other parts of the world. More precise correlations derived from 95 microfaunal and microfloral taxa are in agreement with lithostratigraphic and macrofaunal studies. Ages suggested by preliminary foraminiferal zonation range from middle Tournasian, for the uppermost Banff, to latest Viséan, for the lower Etherington. Data are too meagre yet to delineate the Kinderhook-Osage boundary. The Shunda-Turner Valley contact corresponds to the Tournaisian-Viséan boundary, which is equivalent to the Osage-Meramec boundary. —*from* Authors' abstract

Pettijohn, F. J. *See* Walker, Roger G. 02696

Pettijohn, F. J. *See* James, H. L. 02780

02994 **Péwé, Troy L.** Terraces of the middle Salt River Valley—[Pt.] 1, Progress report [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 64, 1970.

Phair, George. *See* Hickling, Nelson L. 02388

Phares, Roderick S. *See* Visher, Glenn S. 02694

Philbin, Philip W. *See* Senftle, Frank E. 02932

02702 **Philcox, Michael E.** Reefs and wave action [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 864, 1970.

02448 **Phipps, C. V. G.; King, L. H.** Chemical, mineralogical and textural variations in sediments from the Scotian Shelf: Maritime Sediments, v. 5, no. 3, p. 101-112, illus., tables, 1969 [1970].

In a suite of 17 samples from the Scotian Shelf off Nova Scotia, at least two from each of 5 or 6 facies represent the average or the extreme variation. On now isolated banks, well above sea level when glaciers receded, the coarse fraction is similar to the till and bedrock source in western Nova Scotia; marine-terrace sands were derived by subaerial erosion and shorewaves, fines carried to deeper parts. Major-element analyses and normative mineral contents are tabulated; chemical data are plotted against median diameters, mainly quartz. No major change in mineralogy or chemistry seems to result from diagenesis, only minor formation of glauconite, particle adsorption of iron, and bioclastic contributions. In quantitative comparison, use of normative mineral composition circumvented the problem of wide textural variation. — GDC

02703 **Picard, M. Dane; Aadland, Rolf; High, Lee R., Jr.** Shelf-edge carbonate-redbed transitions, Red Peak and Thaynes Formations (Triassic), western Wyoming and adjacent Idaho [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 864-865, 1970.

Pierce, Jack W. *See* Byrnes, John B. 02595

02782 **Pilbeam, David.** The evolution of Man: New York, Funk and Wagnalls, 216 p., illus., 1970.

Pinder, George F. *See* Trescott, Peter C. 02418

02557 **Piotrowski, J. M.; Edgar, A. D.** Melting relations of undersaturated alkaline rocks from South Greenland, compared to those of Africa and Canada: Medd. Grönland, v. 181, no. 9, 62 p., illus., tables, 1970.

Sixteen volcanic and plutonic undersaturated alkaline rocks from Greenland, Africa, and Canada were examined petrographically and their melting relations determined at 1 atm pressure in air; four samples were melted in an argon environment and six at water vapor pressures up to 2,070 bars. At 1 atm pressure, liquidus temperatures

range from 1,120° to 1,230°C; in a nonoxidizing atmosphere they are similar, but are lowered by water vapor pressures as much as 300°, with the initial 1,000 bars pressure the most effective. In most of the samples the crystallization sequence is nepheline, feldspar, and pyroxene at 1 atm pressure. Argon atmosphere and water vapor pressure alters this sequence for some rocks. Those showing agpaitic trends and high volatile contents have longer melting intervals. Relations between liquidus temperatures, chemistry, and petrography are discussed. — *from* Author's abstract

02904 **Pluhowski, E. J.** Effects of urban development on the hydrology of Long Island, New York, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 21-1—21-9, illus. [1970].

This study evaluates the use of infrared imagery in detecting man-induced changes in the thermal patterns of water bodies and nearby land areas. Missions were flown near and parallel to the northern shoreline of Great South Bay on Long Island. Previously recorded temperature data for five streams were correlated with thermal patterns reflected by infrared imagery from the 8μ to 14μ wave-length range obtained in July 1967 during Mission 53. Variations in intensity of the image corresponded to variations in stream temperatures known to be affected by urban development or industry. Results of an August 1, 1968 thermal survey of a waterfront recreation area near East Islip also revealed a definite correlation between variations in intensity of the imagery and variations in actual ground-surface temperatures. — EH

02912 **Polcyn, F. C.** Surface effects and submerged features, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 46B1-46B18, illus. [1970].

For location and measurement of submerged oceanographic features, remote sensors rely on color and thermal anomalies, wave-refraction effects, and time differences of reflected laser pulses. Various sensor types used to discern these observable factors are listed, and problems of and recommendations for their use are described. Data collected by NASA aircraft on mission 72 over the Lake Michigan Test Site 167 in May 1968 are analyzed to ascertain the conditions necessary for a reliable depth determination from observed surface anomalies. Investigations of the use of wave refraction effects related to changing depths near sand beaches and of thermal anomalies associated with shore processes are described. — EH

Poole, Forrest G. *See* Stewart, John H. 02400

02856 **Poulovassilis, A.** Hysteresis of pore water in granular porous bodies: Soil Sci., v. 109, no. 1, p. 5-12, illus., table, 1970.

The hysteresis behavior of granular porous bodies are reported and compared with predictions. A method is described for the direct determination of the relationships between moisture content and suction and moisture content and hydraulic conductivity. — JWH

02859 **Poulovassilis, A.** The effect of the entrapped air on the hysteresis curves of a porous body and on its hydraulic conductivity: Soil Sci., v. 109, no. 3, p. 154-162, illus., 1970.

Experimental results concerning the effects of the entrapped air on the hysteresis curves as well as on the hydraulic conductivity are reported. Air is always entrapped in the same pores if wetting is repeated in the same smooth and uniform manner. The amount of air entrapped willl depend upon the degree of desaturation attained during initial drainage for saturation. — JWH

02805 **Powell, Richard L.** Limestone caverns: Sci. and Children (Washington, D.C., Natl. Sci. Teachers Assoc.), v. 7, no. 6, p. 36-38, 41, illus., 1970.

This popular account of Mammoth Cave, Kentucky, describes the geologic setting, present ground-water conditions, cavern development within the fluctuating zone, and episodes of landscape and cavern development. — MCM

Press, F. *See* Bullen, K. E. 02869

02810 **Press, Frank.** Earth models consistent with geophysical data, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 3-22, illus., tables, 1970.

A suite of recent geophysical data are inverted by a Monte Carlo procedure; data are derived from surface waves for oceanic paths, eigenvibrations of the Earth, elastic wave traveltime and $dt/d\Delta$ data, mass and moment of inertia of the Earth. A low velocity zone is required for the suboceanic mantle as is a high density lithosphere. High density is related to eclogite fractionation from underlying asthenosphere in a process involving lithosphere creation and spreading. If the asthenosphere is pyrolite or peridotite, an increase of mean atomic weight across the transition zone seems required. Fairborn's new $dt/d\Delta$ data for the lower mantle show a higher shear velocity gradient than previously supposed; if correct, a compensatory lower density gradient is required which indicate depletion of iron with depth in the lower mantle. Density at the top of the core is well constrained to the range 9.9-10.2 g/cm^3, appropriate for a mixture of iron and about 15 wt percent silicon. — *from* Author's abstract

Preston, H. *See* Donnay, G. 02235

Preston, H. *See* Donnay, Gabrielle. 02708

Prinz, Martin. *See* Nehru, C. E. 02373

02511 **Pryslak, A. P.** Dent Township, District of Kneora (Patricia Portion): Ontario Dept. Mines Prelim. Geol. Map P. 592, scale 1 in. to 1/4 mi., text, 1970.

Early Precambrian rocks of Dent and Mitchell (Map P. 593, Pryslak, 1970) Townships are predominantly metavolcanic, intercalated with minor amounts of metasediments and intruded by concordant to irregular-shaped bodies of felsic to mafic rocks; it is estimated that the original stratigraphic sequence is about 40,000 feet thick. The rock sequence has been isoclinally folded into a syncline; two faults have been traced. Known gold occurrences are in quartz veins containing minor sulfides, pyrite being most common. — MCM

02512 **Pryslak, A. P.** Mitchell Township, District of Kenora (Patricia Portion): Ontario Dept. Mines Prelim. Geol. Map P. 593, scale 1 in. to 1/4 mi., text, 1970.

The text for Mitchell Township is the same as that for Dent Township (Map P. 592, Pryslak, 1970). — MCM

02704 **Purdy, Edward G.** Reef configurations — Some causes and effects [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 865-866, 1970.

02442 **Pyle, Thomas E.; Tieh, Thomas T.** Strontium, vanadium, and zinc in the shells of pteropods: Limnology and Oceanography, v. 15, no. 1, p. 153-154, table, 1970.

X-ray fluorescence analyses of pteropod shell samples taken from two cores and a trawl that touched bottom in the Gulf of Mexico provide the first detection of Zn in pteropod shells and the first determination of Sr, V, and Zn concentrations in *Diacria trispinosa* shells. Analyses are compared with those of six previous studies; it is obvious that more comprehensive work is required to learn whether pteropods are significant contributors of certain elements to sediments or whether, as suggested by the high values for cored vs. waterborne samples, they take up certain trace elements from the sediments after burial. — VMJ

Quade, Jack. *See* Blinn, John C., 3d. 02851

Qualls, B. R. *See* Tryggvason, E. 02720

02902 **Quigley, R. M.; Vogan, R. W.** Black shale heaving at Ottawa, Canada [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 106-112, illus., 1970.

Three inches (7.6 cm) of differential heave has caused severe structural deformation of a lightly loaded building founded directly on drained black shale bedrock in Ottawa, Canada. Portions of the building founded on shale below the water table have not heaved. The heave is attributed to oxidation of disseminated iron sulfide in the shale by autotropic bacteria to produce secondary hydrous sulfates of greater volume. Autotrophic bacteria of the *Ferrobacillus* and *Thiobacillus ferrooxidan* types, which cause this type of oxidation in warm, drained, humid environments, were confirmed by laboratory cultures to exist in rock waters. The potential importance of heave and sulfate attack on future underground concrete structures in areas of Ottawa underlain by black shale is discussed. — Author's abstract

Raats, P. A. C. *See* Scotter, D. R. 02860

Radcliffe, S. V. *See* Green, H. W., 2d. 03008

02985 **Ragan, Donal M.; Sheridan, Michael F.** The Archean rocks of the Grand Canyon, Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 66, 1970.

02299 **Rahmani, R. A.** Carbonate concretions in the Upper Cretaceous Cedar District Formation, British Columbia: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 282-288, illus., 1970.

The Upper Cretaceous Cedar District Formation of British Columbia contains carbonate concretions of varied shapes and sizes, chiefly of calcite but with detrital grains abundant where the concretions are located in silty or sandy beds. Indications that the concretions were formed immediately after deposition of the host sediments or shortly after shallow burial are: animal borings or burrows in the concretions filled with sediment from the host beds, thickening of the host beds around the concretions, random orientation with respect to bedding and lamination and stretching and folding where present in beds showing soft-sediment deformation, undeformed bivalved shells in the concretions, scarcity of grain-to-grain contacts among the included detrital grains and the undeformed mica plates. They probably grew due to precipitation of $CaCO_3$ near decomposing organic matter in reducing and high pH environments. — *from* Author's abstract

02670 **Rainwater, E. H.** Geologic occurrence of oil and gas in Miocene of Gulf Coast of United States [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 866, 1970.

02362 **Ramanatha Iyer, T. S.** Causes of clay sensitivity — Discussion [of paper 6568 by James K. Mitchell and William N. Houston, 1969]: Am. Soc. Civil Engineers Proc., v. 96, Jour. Soil Mechanics and Found. Div., no. SM2, p. 774-776, 1970.

For original paper *see* ibid., v. 95, no. SM3, p. 845-871, 1969; Abstracts of North American Geology, April 1970. — GDC

Ramdén, Hans-Åke. *See* Reyment, Richard A. 02382

02272 **Rancitelli, L. A.; Perkins, R. W.; Kaye, J. H.; Cooper, J. A.; Wogman, N. A.** Cosmogenic and primordial radionuclide concentrations in the Lost City meteorite [abs.]: EOS, v. 51, no. 7, p. 581-582, 1970.

Randall, Walter. *See* Rex, Robert W. 02363

Rapp, G. R., Jr. *See* Finger, L. W. 02240

02485 **Raymond, Loren A.** Cretaceous sedimentation and regional thrusting, northeastern Diablo Range, California: Geol. Soc. America Bull., v. 81, no. 7, p. 2123-2128, illus., 1970.

Stratigraphic and structural details in the juxtaposed Franciscan and Great Valley sequences allow restriction of the age of regional thrusting or gravity sliding. The Cretaceous section consists of three sandstone-shale units: Albian-Turonian Adobe Flat Shale, Coniacian-Campanian Panoche Formation, and Campanian-Maestrictian Moreno Formation. The upper and lower units are absent locally and the middle unit varies in thickness between the Del Puerto Creek and Byron-Tesla areas, apparently from differential deposition over a topographic high that corresponds with the present location of the Mount Oso anticlinorium. If the anticlinorium was there during Panoche time, no large-scale tectonic transport has occurred since the Coniacian in the northeastern Diablo Range. — EHP

02943 **Rayner, J. M.** The role of geophysics in the development of mineral resources [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 259-266, illus., 1970.

Many examples may be given where geophysics has been the decisive factor in development of mineral resources, nevertheless, mineral production is still predominantly from traditional mining areas and only a modest proportion can be directly attributed to geophysics. At the present time there is an urgent need for keener tools. Existing methods are being used on a fairly substantial scale, their usage is steadily increasing and some notable discoveries are being made. Vast stretches of potentially mineralised country still lie hidden beneath comparatively thin cover, many lenticular orebodies are believed to occur at accessible depths and additional mineral resources no doubt lie on and beneath the continental shelves. In the years ahead mining geophysics will play a vital role in the development of mineral resources; however, the extent to which it can do so will depend upon emergence of more powerful methods. — *from* Author's abstract

02671 **Reed, Philip E. C.** Discontinuity surfaces in Beaverhill Lake Group (Devonian) limestones, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 866, 1970.

02473 **Reed, T. E.; McMurtrey, R. G.** Water levels and artesian pressures in observation wells in Montana, 1966-69: Montana Bur. Mines and Geology Bull. 76, 36 p., illus., tables, 1970.

Initial source of most ground water in Montana is precipitation, which varies from 13.07 in. in the north-central division to 19.04 in. in the western division. Ground water occurs under a wide range of conditions; throughout most of the state, wells drilled into one or more of the numerous aquifers produce water, but not necessarily at a reasonable cost or in quantity or of quality desired. Water-level fluctuations are cyclic; levels generally rise during spring and summer and decline during fall and winter. Well descriptions and water-level measurements are tabulated by county. — MCM

Reeve, F. A. E. *See* Smith, Derrell A. 02347

02977 **Reeves, R. W.** Arroyos outside the southwest [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 56-57, 1970.

02498 **Reig, Osvaldo A.** The Proterosuchia and the early evolution of the Archosaurs, an essay about the origin of a major taxon: Harvard Univ. Mus. Comp. Zoology Bull., v. 139, no. 5, p. 229-292, illus., table, 1970.

The proterosuchian thecodonts were probably derived from the ophiacodont-varanopsid group of pelycosaurian synapsids. The two groups of diapsids, reptiles, lepidosaurians and archosaurs have quite different origins. The final establishment of the archosaurian orders as dominant reptiles of Jurassic and Cretaceous was the outcome of a gradual process, one which had an exploratory phase during the Middle and Late Triassic in which several archosaurian lines developed, competing among themselves and with therapsids. During Late Permian, plant-eaters and carnivores were synapsids, but from uppermost Triassic to the end of the Cretaceous were archosaurs. The origin of a major taxon is thus thought of as a long process involving

several adaptive phases within the frame of the exploitation of food resources and of ecological competition. — *from* Author's abstract

02672 **Reineck, Hans-Erich; Howard, James D.; Frey, Robert W.; Dorjes, Jurgen; Hertweck, Gunther.** Characteristics of shoreface sediments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 866, 1970.

Remson, Irwin. *See* Hornberger, George M. 02716

02363 **Rex, Robert W.; Randall, Walter.** Possible sea-floor spreading in the Imperial Valley of California — [Pt.] 5, Present centers [abs.]: EOS, v. 51, no. 7, p. 589, 1970.

02382 **Reyment, Richard A.; Ramdén, Hans-Åke.** FORTRAN IV program for canonical variates analysis for CDC 3600 computer: Kansas Geol. Survey Computer Contr. 47, 40 p., table, 1970.

This FORTRAN IV program for canonical variates for a maximum of 30 variables performs several functions: (1) basic statistics for each sample are computed and the covariance matrices tested for homogeneity; (2) the generalized determinantal equation is solved and eigenvalues tested for significance; (3) the mean vectors are tested in a one-way multivariate analysis of variance for significant difference; and (4) the first two elements of the transformed mean vectors and transformed observations are plotted. Application of the program is illustrated by two examples: observations on Upper Cretaceous echinoids from England and matrix input data from an anthropomorphic problem. — Authors' abstract

Reynolds, M. *See* Bogard, D. D. 02270

02992 **Richards, Horace G.** Changes in shoreline during the past million years: Am. Philos. Soc. Proc., v. 114, no. 3, p. 198-204, illus., 1970.

Eustasy, the weight of glacial ice on the land, and tectonic movement are cited as the geological processes which change the relative position of sea and land and affect Quaternary shorelines in many parts of the world. Results of work along the Atlantic Coast from New Jersey to Florida are reviewed; there is good evidence of a sea level at +28 feet and possibly another at +50 feet dating from the warm Sangamon interglacial. Shoreline changes in other parts of the world are discussed briefly. During the Holocene, sea level rose from its low Wisconsin level to that of today. Theories on the rate and details of this rise are discussed, as well as the correlation between Holocene sea-level changes and archeology. — EH

Richart, F. E., Jr. *See* Drnevich, Vincent P. 02356

02403 **Ricketts, T. E.; Goldsmith, W.** Dynamic properties of rocks and composite structural materials: Internat. Jour. Rock Mechanics and Mining Sci., v. 7, no. 3, p. 315-335, illus., tables, 1970.

The response of plutonic, sedimentary, and volcanic rocks, and structural materials [portland cement and igneous aggregates combined] to dynamic loading was studied by measuring passage of stress waves in ballistically-suspended Hopkinson bars. Transient loading was by longitudinal impact of a 1/2-in diameter steel sphere at velocities up to 10,000 in/sec. Results from single wave passage and from multiple reflections indicate some rocks exhibit virtually no change in pulse shape, while attenuation in increasing degree was observed in volcanics with no alteration in wave profile. Pulse propagation in sandstone revealed a significant change in pulse shape and artificial composites behave similarly to concrete. Examination of static properties of specimens in unshocked and shocked state revealed little difference except for diorite, which showed significant deterioration in physical characteristics as a consequence of wave passage. — *from* Authors' abstract

02722 **Rickman, Ron W.** Soil structure evaluation with audiofrequency vibrations: Soil. Sci. Soc. America Proc., v. 34, no. 1, p. 19-24, illus., table, 1970.

Young's moduli for soils measured with a vibrational technique varied with soil aggregate size, water content, texture, sensor-to-sample contact, and column handling. Its magnitude varied from 10^7 dynes/cm^2 (147 psi) for nearly saturated columns to over 10^9 dynes/cm^2 for an air-dried, Na-saturated silt. The accuracy of the moduli measurements is of the order of 15 to 20 percent. The measured values compare favorably with others previously reported in the literature for undisturbed and reworked soil samples. The range of measured soil moduli, the repeatability of the measurements, the lack of restriction on sample size and the nondestructive nature of the technique indicate that this procedure may provide a useful measure for soil structure evaluation. — *from* Author's abstract

Riecker, Robert E. *See* Rooney, Thomas P. 02794

Rieke, Herman H., 3d. *See* Merriam, Richard. 02308

02393 **Robinson, Edwin S.** Relations between geological structure and aeromagnetic anomalies in central Nevada: Geol. Soc. America Bull., v. 81, no. 7, p. 2045-2060, illus., table, 1970.

Data from a 6000 km^2 aeromagnetic survey of central Nevada is interpreted to suggest relations between near-surface geology and that at intermediate depths. Magnetic anomaly lineations were analyzed by a method sensitive to the amplitude of the anomaly that involved digital fan filtering and autocovariance computations which yields a north-northwest trend. The second method, by a graphical analysis of lineation lengths and azimuths that is nonsensitive to anomaly amplitude, indicates a dominant N.10°E. trend, the effect of near-surface structure. The north-northwest trending zone of anomalies, along an alinement of windows through the Roberts Mts. thrust fault, is interpreted as related to emplacement of magnetic material in areas domed during the late Paleozoic and Mesozoic. — *from* Author's abstract

02419 **Rockaway, John D., Jr.** Trend-surface analysis of ground-water fluctuations: Ground Water, v. 8, no. 3, p. 29-36, illus., 1970.

Trend-surface analysis of hydrogeologic data from Bartholomew County, Ind., indicates that this method can provide a rapid, inexpensive means of delineating attractive areas for detailed ground-water investigations. Trend-surface maps and maps of the derivations from the trend-surfaces were prepared from water-level data and evaluated to establish their relationships with the hydrogeologic regimen. A field-testing program was carried out to evaluate aquifer parameters. On the basis of results from these studies the following conclusions were drawn: (1) A mathematically fitted surface may be considered to approximate the water table and will be sensitive to fluctuations in the ground-water reservoir. (2) The anomalous areas of the trend-surface represent local effects superimposed on the regional base and may be explained by a particular set of geologic, hydrologic, or man-made conditions. — *from* Author's abstract

02483 **Roed, M. A.** Surficial geology, Edson (NTS 83F): Research Council Alberta Map 33, scale 1:250,000, 1970.

02673 **Rold, John W.** A new look at old provinces [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 866-867, 1970.

Romanov, V. I. *See* Bilyavs'kiy, G. O. 02555

02470 **Romer, Alfred Sherwood.** A new anthracosaurian labyrinthodont, *Proterogyrinus scheelei*, from the lower Carboniferous: Kirtlandia, no. 10, 16 p., illus., 1970.

Incomplete remains of the skull and skeleton of an anthracosaurian labyrinthodont from the basal part of the Mauch Chunk Group of the Mississippian of Greer, West Virginia, are described as *Proterogyrinus scheelei*, gen. et sp. nov. and made the type of a new family Proterogyrinidae. The type resembles the Embolomeri in most regards but is more primitive in that both intercentra and pleurocentra are in the form of dorsally incomplete rings. — Author's abstract

02794 **Rooney, Thomas P.; Riecker, Robert E.; Ross, Malcolm.** Deformation twins in hornblende: Science, v. 169, no. 3941, p. 173-175, illus., table, 1970.

Hornblende deformation twins with twin planes parallel to (I01) are produced experimentally in single crystals by compression parallel to the c axis. Twinning occurs at confining pressures from 5 to 15 kilobars and temperatures from 400° to 600°C (strain rate, 10^{-5} per second). — Authors' abstract

02855 **Rose, E. R.** The ferride element content of titaniferous magnetite in Canada: Canada Geol. Survey Paper 69-54, 9 p., illus., table, 1970.

The term titaniferous magnetite is defined, and historical progress in the knowledge and utilization of titaniferous magnetite is summarized. The distribution and nature of titaniferous magnetite deposits in Canada is outlined and reference is made to the general geology and mineralogy. Much new analytical data on the ferride element content of titaniferous magnetite is shown in a table. Comparisons made between the analyses of natural titaniferous magnetite (crude potential ore material) with those of magnetic concentrates made from them, give a measure of both the grade and relative ease of concentration of most of the occurrences. The high metal content of the magnetic concentrates made from many samples of titaniferous magnetite deposits suggests that they should be given consideration as sources of materials from which iron, titanium, and vanadium, as well as other elements and minerals might be recovered. — Author's abstract

Rose, Harry J., Jr. *See* Hickling, Nelson L. 02388

Ross, Malcolm. *See* Rooney, Thomas P. 02794

02739 **Rough, R. L.; Overbey, W. K., Jr.** Lithologic descriptions of Appalachian area oil-producing formations: U.S. Bur. Mines Inf. Circ. 8473, 133 p., illus., tables, 1970.

Lithologic descriptions of petroleum reservoir rocks of Silurian, Devonian, Mississippian, and Pennsylvanian age in Ohio, Pennsylvania, and West Virginia, which were cored as part of a study of secondary recovery techniques, are presented along with maps and stratigraphic, engineering, and geographic information. — ERL

Rouse, John T. *See* Clark, Robey H. 02599

02277 **Rowe, Royle C.** Hunting Utah trilobites: Gems and Minerals, no. 394, p. 28-29, 50-51, illus., 1970.

This popular account of fossil collecting localities, particularly the Antelope Springs area, includes suggestions on state and federal restrictions for amateur collectors. — MCM

Rowell, Bruce F. *See* Griesemer, Allan D. 02526

02489 **Rowland, Mark R.; Kunkle, George R.** Cones of influence developed in the Silurian-Devonian aquifer, Maumee River basin, Ohio: Ground Water, v. 8, no. 3, p. 37-43, illus., tables, 1970.

In the Maumee River basin of northwestern Ohio, the principal source of ground water is the Silurian-Devonian carbonate aquifer. To encourage efficient groundwater development in the area quantitative information on the resource potential of the aquifer is needed. This paper demonstrates a relationship between ground-water use and recharge rate through an analysis of cones of influence. Computed recharge rates vary from 6,800 to 75,300 gpd/sq mi; the variation is systematic in that the higher recharge rates correlate with the higher pumping rates. Recharge rates have an upper limit of 100,000 gpd/sq mi, which corresponds to a maximization of the vertical hydraulic gradient. Maximization gradient can be approached by lowering the piezometric surface of the aquifer by increasing the pumping rate. Assuming that the safe yield of an aquifer is equivalent to the rate of recharge, this study demonstrates that development of an aquifer can increase its potential. — *from* Authors' abstract

Roy, Rustum. *See* Berkes, John S. 02997

02981 **Royse, Chester F., Jr.; Sheridan, Michael F.** Alunite, a new occurrence near Wickenburg, Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 63, 1970.

Runcorn, S. K. *See* Bullen, K. E. 02869

Runge, E. C. A. *See* Ballagh, T. M. 02570

02831 **Russell, Dale A.** The vertebrate fauna of the Selma Formation of Alabama — Pt. 7, The mosasaurs: Fieldiana — Geology Mem., v. 3, no. 7, p. [363]-380, illus., 1970.

The reptilian fauna of the Mooreville Chalk, in the lower Selma Group, Cretaceous, central Alabama, is now known to contain at least eight species of mosasaurs; seven are described here. The Mooreville is equivalent in age to the upper Niobrara Chalk and lower Pierre Shale of Kansas and South Dakota; their mosasaur assemblages are compared. *Clidastes sternbergi* Wiman, 1920, is here referred to *Halisaurus* on the basis of conspecific Mooreville specimens. *Tylosaurus zangerli* n.sp. is more primitive than Niobraran tylosaurs. *Clidastes propython* is the predominant species in the Mooreville, whereas *Platycarpus* is predominant in the Niobrara and Pierre; possible paleoecologic differences are discussed. *Globidens alabamensis* and undetermined species of *Tylosaurus*, *Platycarpus*, *Prognathodon* are also described from the Mooreville. — VMJ

02534 **Russell, John L.** Permian-Cretaceous unconformity in Marion County, Kansas [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 37, 1970.

02972 **Russell, Richard H.** Biogeography of late Cenozoic Mollusca from the San Pedro Valley, southeastern Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 22-23, 1970.

02409 **Ryder, Robert T.; Ames, H. Tate.** Palynology and age of Beaverhead Formation and their paleotectonic implications in Lima region, Montana-Idaho: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1155-1171, 1970.

The Beaverhead Formation, a thick unit of conglomerate and sandstone, records major tectogenic and morphogenic events in the Lima region of southwestern Montana and adjacent Idaho. Pollen and spore assemblages from the formation indicate that Beaverhead sedimentation started as early as late Albian (late Cretaceous) and persisted into the middle to late Paleocene. Tectonic elements which generated the Beaverhead sediments and later deformed them are the Blacktail-Snowcrest arch, the Ancestral Beaverhead Range and uplift in the geosyncline of central Idaho. Later deformation of the sediments was caused by the Tendoy, Cabin, and Fritz Creek upthrusts of mid-Paleocene to the late Paleocene or early Eocene age. — *from* Authors' abstract

02312 **Sahl, H. L.** Mobeetie field economics justifies search for similar areas: Oil and Gas Jour., v. 68, no. 9, p. 100-102, 104-106, illus., table, 1970.

Mobeetie anticline lies on a regional horst that approximately parallels the Amarillo uplift on the southwestern edge of the Anadarko basin, Wheeler County, Tex. The Pennsylvanian-Permian sequence of the Mobeetie field contains abundant granite wash that reflects movement along the Amarillo uplift during Pennsylvanian and early Permian time. Oil and gas production is chiefly from granite wash of Virgil and Missouri age, but production also comes from a bioherm of Missouri age and from the Ellenburger. It is estimated that ultimate recovery from all zones will return 3 dollars for each dollar invested. — WBC

02674 **Sahu, Basanta K.** Correlation of mean sizes obtained from size measurement by thin-section and loose-grain methods [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 867, 1970.

Saitta-Bertoni, Sandro. *See* Visher, Glenn S. 02694

Sammis, Charles. *See* Anderson, Don L. 02871

Sandberg, Charles A. *See* Gutschick, Raymond C. 02623

02444 **Sanger, Jon E.; Gorham, Eville.** The diversity of pigments in lake sediments and its ecological significance: Limnology and Oceanography, v. 15, no. 1, p. 59-69, tables, 1970.

Thin-layer chromatography of samples of the top 10 cm of sediments collected from near the deepest spots of 18 Minnesota lakes, and of sediment samples from six lakes of the English Lake District, shows a large number of pigments (chlorophyll derivatives and carotinoids), diversity being somewhat greater in eutrophic than in oligotrophic lakes. Sedimentary pigments are much more numerous (24-47) than those of upland vegetation (7-8), aquatic macrophytes (12-15), and planktonic algae (10-21). Algal decomposition, which is accompanied by a marked increase in number of pigments, seems the most likely cause for the extreme diversity. Apparently little further alteration of pigments occurs once organic matter has settled into an anoxic environment beneath the mud-water interface. — *from* Authors' abstract

Sarigianis, Perry. *See* Senftle, Frank E. 02932

02867 **Sartz, Richard S.** Natural freezing and thawing in a silt and a sand: Soil Sci., v. 109, no. 5, p. 319-323, illus., tables, 1970.

In southwestern Wisconsin, the frost penetration in the winter of 1967-68 was faster and deeper and thawed sooner in sandy soil. The hardening of frost during freezing caused by the movement of water from liquid to solid decreased permeability. The author suggests that the present method of classifying frozen soil by type and depth and persistence is not adequate for hydrologic purposes. — JWH

Sauer, E. Karl. *See* MacDonald, A. B. 02901

Sayles, F. L. *See* Manheim, F. T. 02652

02282 **Sayyah, Taha; Gast, Paul W.; Whelan, J. A.** Raft River Range, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 19, 1970.

The Raft River Range is an east-west trending anticline made up of the Precambrian Harrison series and the overlying Dove Creek Formation; unmetamorphosed Paleozoic formations overlie the Dove Creek. Employing the whole-rock Rb-Sr method, ages of 2,430 m.y. for the massive granite and 3,732 m.y. for the metamorphic granite were obtained. These data were the first to indicate that old Precambrian rocks exist as far west and south as Utah in the North American continent. — MCM

02847 **Schaber, Gerald G.** Radar and infrared in geological studies of northern Arizona, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 13-1 — 13-29, illus., [1970].

Various types of airborne remote-sensing data were obtained for four areas in northern Arizona over a period of three years. Radar imagery was found valuable for its synoptic scale, moisture delineation and topographic enhancement capabilities, which are useful in interpreting tectonics, surface moisture and overlapping sequences of lava flows. Infrared scanner imagery enables location of prehistoric Indian agricultural sites, discrimination between recent, dark (unweathered) volcanic ash and lighter, older (weathered) ash-fall deposits. Neither technique was successful in distinguishing rock types. Parameters of surface textures, moisture content, and changing atmospheric conditions must be understood in order to obtain scientific evaluations of imagery. — EH

02453 **Schafer, C. T.** Distribution of foraminifera along the west coasts of Hudson and James Bays, a preliminary report: Maritime Sediments, v. 5, no. 3, p. 90-94, illus., table, 1969 [1970].

Thirty-eight species of foraminifera, eight of them extant, have been identified from bottom sediments of seven major estuaries. Most specimens represent fossil forms eroded from late-glacial marine deposits that crop out along the river channels and extend more than 100 miles inland throughout much of the lowland area. At one station on a bank of the Albany River, these older marine sediments contain 10 species. Comparing total number of identified species with depth zonation data of Leslie (1965), 24 percent may be included in his "Shallow Bay Fauna;" of the remainder, 20 percent belong to his "Intermediate" and 22 percent to his "Deep Bay" fauna; about 40 percent can be included in his "Cosmopolitan Bay Fauna." Presence of intermediate and deep bay forms emphasizes further the erosion and redeposition of fossil specimens responsible for some sample contamination from mixing with living populations presently in the estuaries. — GDC

Schairer, J. F. *See* Kushiro, I. 02250

Schairer, J. F. *See* Mao, H. K. 02253

02256 **Schairer, J. F.; Yoder, H. S., Jr.** Critical planes and flow sheet for a portion of the system CaO-MgO-Al_2O_3-SiO_2 having petrological applications: Carnegie Inst. Washington Year Book 68, 1968-69, p. 202-214, illus., 1970.

02675 **Schanz, John J., Jr.** Economic aspects of exploration and development of mineral resources, viewpoint of educator [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 868, 1970.

02462 **Scheidegger, A. E.** On the theory of evolution of river nets: Internat. Assoc. Sci. Hydrology Bull., v. 15, no. 1, p. 109-114, illus., tables, 1970.

An investigation is made of the growth of river basins based on the two current models of the structure of such basins: the cyclic model and the random-graph model. Based on the assumption that the networks grow allometrically, the structure of the network that evolves has been calculated based upon the above two models. Nature seems to favor the random-graph model. — Author's abstract

02353 **Schiffman, Robert L.; Whitman, Robert V.; Jordan, Jane C.** Settlement problem oriented computer language: Am. Soc. Civil Engineers Proc., v. 96, paper 7178, Jour. Soil Mechanics and Found. Div., no. SM2, p. 649-669, illus., tables, 1970.

Settlement Problem Oriented Language (SEPOL), designed to aid civil engineers in the calculation of predicted magnitudes and progress of settlement for shallow foundations, is a problem oriented computer language which permits machine instructions to be entered by means of commands. The commands are English phrases, each one specifying a particular operation to be performed. The version of SEPOL described here operates within the framework of the Integrated Civil Engineering System. Two examples are given: the first calculates the stresses beneath a rockfill dam; the second presents the calculations of the magnitude and progress of settlement beneath a test fill. Future applications of computers to soil engineering are described. — *from* ASCE abstract

02676 **Schlaepfer, Carmen J.; Pablo Galán, Liberto de.** Clay mineralogy of series of redbeds in State of Oaxaca, Mexico, and its geologic significance [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 868, 1970.

02677 **Schmidt, Volkmar.** Diagenesis of Keg River bioherms, Rainbow Lake, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 868, 1970.

02966 **Schoenfeld, I.** Spectrographic determination of fluorine in standard rocks: Appl. Spectroscopy, v. 24, no. 3, p. 359-361, tables, 1970.

The dc spectrochemical method based on the emission of CaF bands has been adapted to the determination of fluorine in standard rocks. The main difficulty of the spectrochemical method, namely, the need to prepare suitable working standards for each sample, was circumvented by using the single addition method. In the excitation step the problem arising from the difference in the volatility of Ca and F, which

results in nonuniform supply of these elements to the arc, was overcome by burning the samples in the Stallwood jet. The coefficient of variation for a single determination is about 15 percent. The results for 10 standard rocks are presented and compared with previously published data. — Author's abstract

02678 **Schroeder, Johannes H.; Friedman, Gerald M.; Miller, Donald S.** Uranium distributions in recent skeletal carbonates [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 869, 1970.

02705 **Schutz, Donald F.; Senechal, Ronald C.** Applications of potassium-argon dating in oil exploration [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 869, 1970.

02822 **Sclar, C. B.** High pressure studies in the system MgO-SiO_2-H_2O [abs.], *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 333, 1970.

02785 **Scott, Gerald L.** Bethany Falls Limestone (Missourian) sedimentation and diagenesis, Missouri and Kansas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 869, 1970.

02335 **Scott, Robert W.** Stratigraphy and sedimentary environments of Lower Cretaceous rocks, southern western interior: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1225-1244, illus., table, 1970.

Studies of 48 measured sections of Upper Albian rocks, the Cheyenne Sandstone and Kiowa Formation in Kansas and western Oklahoma, Tucumcari Formation in New Mexico, and Purgatoire Formation in and adjacent to southeastern Colorado, indicate four ammonite-bivalve zones are useful for time correlations of these units and with others in Texas. The rocks record marine transgression and regression from the Gulf Coast region. Depositional environments indicated are: coastal plain, shown by fluviatile sandstones in the Cheyenne and Purgatoire; sea margin, by thin bedded sandstone and mudstone of the Kiowa, Purgatoire, and Tucumcari; and open-sea, by dark-gray shale of the Kiowa, Purgatoire, and Tucumcari. — EGS

02860 **Scotter, D. R.; Raats, P. A. C.** Movement of salt and water near crystalline salt in relatively dry soil: Soil Sci., v. 109, no. 3, p. 170-178, illus., 1970.

Columns of soil were set up with a layer of salt at one end. After a period of time, they were sectioned and the water and salt content profiles were determined. The water accumulation was found to occur with a wide range of initial water contents. Columns sampled at different times showed both the water and salt content profiles to be functions of the distance from the soil-salt interface divided by the square root of the experiment time. — *from* Authors' summary

02340 **Sears, Joe M.** Albert Sidney Clinkscales (1894-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1306-1307, portrait, 1970.

Seed, H. Bolton. *See* Lee, Kenneth L. 02355

Seed, H. Bolton. *See* Idriss, I. M. 02413

02956 **Seigel, Harold O.** The induced polarization method [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 123-137, illus., 1970.

Two different field techniques (transient and frequency variation), yielding essentially equivalent information, have been used with the induced polarization method. Instrumentation and field techniques have evolved considerably over the past two decades and theoretical information for quantitative interpretation has been accumulated. IP is the only available method with general application to direct detection of 'porphyry type' and bedded copper deposits as well as bedded lead-zinc deposits in carbonate rocks. Despite a moderate amount of laboratory and field investigation, it

is not feasible in general to differentiate between IP responses due to overvoltage and nonmetallic sources, or between possible sources within each group; it is difficult to equate a specific IP response to a unique percentage of metallic content. — *from* Author's abstract

02740 **Seiglie, George A.** Additional observations on the foraminiferal genus *Buliminoides* Cushman: Cushman Found. Foram. Research Contr., v. 21, pt. 3, p. 112-115, illus., 1970.

Additional evidence on the plastogamic reproduction of the genus *Buliminoides* Cushman is given. Plastogamic specimens of *B. parallela* are illustrated, while specimens of *B. williamsoniana* and *B. stainforthi* found in the same sample are compared to show morphologic differences. The genus *Buliminoides* is redescribed, and the new family Buliminoididae is described. — Author's abstract

Senechal, Ronald C. *See* Schutz, Donald F. 02705

02932 **Senftle, Frank E.; Sarigianis, Perry; Philbin, Philip W.** Neutron activation techniques for precious metal exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 462-469, illus., tables, 1970.

A feasibility study has shown that an *in situ* irradiation of the ground with neutrons can produce sufficient induced radioactivity in some 30 elements to make detection and identification relatively easy. Extensive tests and two prototype field detectors for detection of silver show encouraging results. Induced radioactivity is analyzed by a multichannel analyzer, and element identification is made on the basis of both energy and half-life. A similar study made on precious and semiprecious metals indicates no one technique is satisfactory for all metals. Rather than build a practical field exploration device for precious metals, a mobile neutron activation laboratory has been built to investigate various parameters and techniques. Field tests have been made using both thermal and fast neutron reactions to detect gold. Two of the more promising methods are described and preliminary field results are shown. — *from* Authors' abstract

Shainberg, I. *See* Bar-On, P. 02863

02679 **Shannon, John P., Jr.** Pennsylvanian deltaic stratigraphic traps, eastern shelf, Midland basin, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 869, 1970.

Shao, C.-Y. *See* McCrosky, R. E. 02262

02680 **Sharma, G. D.** Cationic balance and early diagenesis of glaciomarine sediments [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 869-870, 1970.

Shattles, D. E. *See* Boswell, E. H. 02765

02566 **Shaw, Charles E., Jr.** Age and stratigraphic relations of the Talladega Slate, evidence of pre-Middle Ordovician tectonism in central Alabama: Southeastern Geology, v. 11, no. 4, p. 253-267, illus., table, 1970.

Folded and thrust-faulted Lower Paleozoic rocks exposed near Sylacauga, Ala., include the Early Cambrian Weisner, Shady, and Rome Formations, the Middle Cambrian Conasauga Formation, and the Late Cambrian-Early Ordovician Knox Group. These strata were strongly folded and then covered by Talladega sediments in post-Early Ordovician to Devonian time. Upper Knox strata of Early Ordovician age are the youngest rocks known to underlie the Talladega. Basal Talladega rocks are considered post-Early Ordovician in age. Tracing of the Sylacauga section westward indicates that the name "Talladega Slate" should be confined to rocks southwest of the village of Jumbo in Chilton County. The lower part of the Talladega Slate represents a Middle Ordovician clastic wedge in Alabama and its deposition was preceded by a period of relatively strong tectonism. — *from* Author's abstract

02338 **Shawa, Monzer S.** Upper Cretaceous depositional pattern, Coalinga area, California: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1296-1305, illus., 1970.

In the southern part of the Diablo Range near Coalinga, rock units of upper Cretaceous age are the Curry Mountain, Long Canyon, Waltham, Juniper Range, Oak Flat (new), Los Gatos, and Alcalde Formations. Sedimentary structures indicate that episodal paleocurrents moved sediments down the subaqueous slope and moved westward during Cenomanian time and southeastward during Turonian-Coniacian time. Contour currents traveled parallel to the isobaths of the subaqueous slope and redistributed and reworked part of the sediments. The change in direction of the subaqueous slope was the result of tectonic uplift. — SEF

02317 **Shawe, D. R.** Structure of the Slick Rock district and vicinity, San Miguel and Dolores Counties, Colorado: U.S. Geol. Survey Prof. Paper 576-C, p. C1-C18, illus., table, 1970.

Major zones of faults and folds in the Slick Rock district were deformed, at times simultaneously, during deposition of the upper Paleozoic and Mesozoic rocks, as shown by thickness variation of the formations related to zones of faults and the fold axes. The zones of faults appear to be parts of a major regional conjugate (northeast-northwest) system, and deformation on these zones was probably related to folding of the salt anticlines (including Gypsum Valley and Dolores anticlines) and development of the Paradox Basin. Most faults and joints in the zones of faults are younger than Late Cretaceous, and they controlled movement of solutions that epigenetically altered the rock and deposited uranium-vanadium ores probably in early to middle Tertiary time. — DRS

02681 **Shearman, Douglas J.** Evaporite-carbonate relations in basin development [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 870, 1970.

Shelton, John W. *See* Matalucci, Rudolph V. 02306

02350 **Shelton, John W.; Mack, Douglas E.** Grain orientation in determination of paleocurrents and sandstone trends: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1108-1119, illus., table, 1970.

Dielectric anisotropy measurements of grain orientation have been calibrated to paleocurrent indicators, upcurrent grain imbrication, local current trends of Cimarron River in partly impregnated samples, and sandstone trend of lowermost unit of Eagle sandstone of Billings, Montana, and of three lenticular Permian sandstone beds. — JKP

02295 **Shepheard, W. W.; Hills, L. V.** Depositional environments, Bearpaw-Horseshoe Canyon (Upper Cretaceous) transition zone, Drumheller "Badlands," Alberta: Bull. Canadian Petroleum Geology, v. 18, no. 2, p. 166-215, illus., tables, 1970.

Transition zone sediments between the Upper Cretaceous Bearpaw and Horseshoe Canyon Formations in the Drumheller area form part of a major regressive sequence laid down in late Campanian time over central and southern Alberta. During this time, the shoreline of the Bearpaw Sea was forced further to the east with a buildup of continental sediments along the margins. About 10 mi southeast of Drumheller along the Red Deer River, six separate units can be recognized in the transition zone deposits representing: prodelta and delta front, distributory channel, beach and interdistributary bay, mudflat, open bay, and lower floodplain environments of an ancient deltaic complex. Sedimentation occurred relatively rapidly in an unstable environment, with shifting streams the primary transportation and deposition agent. Interpretations were based on sedimentological, petrographic and grain size analyses. — *from* Author's abstract

02976 **Sheridan, Michael F.** Environmental geology [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 38, 1970.

Sheridan, Michael F. *See* Royse, Chester F., Jr. 02981

Sheridan, Michael F. *See* Ragan, Donal M. 02985

Shigeno, Saburo. *See* Uchida, Kinsuke. 02474

Shirk, William R. *See* Geyer, Alan R. 02405

02303 **Shlien, Seymour; Toksöz, M. Nafi.** Frequency-magnitude statistics of earthquake occurrences: Earthquake Notes, v. 41, no. 1, p. 5-18, illus., tables, 1970.

An effort was made to investigate the magnitude frequency relationship of earthquakes as reported in the USCGS Preliminary Determination of Epicenters from 1963-1968 and Gutenberg and Richter and Duda's catalog of earthquakes from 1918 to 1963. The study was carried out for different seismic regions and over different time intervals to look for variations. It is necessary to take into account the dependence of the frequency distribution (especially for low magnitudes), on the detection capabilities of the seismic network which may vary for different regions and over different time intervals. It was found that a second degree curve removes some of the subjectivity in estimating the "b" value. There is still some question whether the regional variations are significant. — Authors' abstract

Shor, G. G. *See* Karig, D. E. 02330

Short, H. A. *See* Conrod, A. C. 02911

02682 **Shouldice, David H.** Geology of western Canadian continental shelf [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 870-871, 1970.

Silver, Leon T. *See* McGetchin, Thomas R. 02825

Simmons, G. *See* Nur, A. 02404

02729 **Simpson, Frank.** Low depth Saskatchewan prospect: Oilweek, v. 21, no. 6, p. 14, 16, 58, illus., table, 1970.

In east-central Saskatchewan, numerous gas and oil shows indicate economic prospects at relatively shallow depths in the Viking, Souris River, Dawson Bay and Winnipegosis formations in the Porcupine Mountain area, until recently reserved from mineral exploration. Only a few cores were taken, but fairly detailed lithologic sequences based on well cuttings were published (Wickenden, 1945). Most wells reached no deeper than the base of the Vermilion River Formation; geophysical records are limited to a few electric logs and scarce gamma logs. There has been little production of natural gas, discovered in the Kamsack region in 1937. It is believed that exploration was inefficiently directed only towards depths of about 200 feet and that shows in most Cretaceous formations may indicate down-dip Vermilion and Viking possibilities. Shows from depths of about 2,000 and 3,000 feet are probably Devonian; gas is suggested in the Winnipegosis at about 1,800 feet. — GDC

02893 **Skermer, N. A.; Hillis, S. F.** Gradation and shear characteristics of four cohesionless soils [with French abs.]: Canadian Geotech. Jour., v. 7, no. 1, p. 62-68, illus., tables, 1970.

Results are compared from drained triaxial tests carried out at confining pressures of 50 and 350 psi [Mica Dam site, on four cohesionless soils, Columbia River, British Columbia]. From the effect of gradation at constant relative density, it is concluded that there is an optimum gradation in terms of both high ultimate and high mobilized strength. Uniform coarse gravel has poor mobilized strength, but, at confining pressures high enough to cause particle crushing, improvement in gradation and packing leads to a high ultimate strength, although large axial strains are necessarily induced. Optimum gradation is shown to be close to Fuller's curve for maximum density. The effect of increasing confining pressure from 50 to 350 psi leads to a decrease in ϕ peak of 6 to 10°, but modifications for dilatancy lead to ϕ_f parameters sensibly constant for any one material. —*from* Authors' abstract

02521 **Skinner, Jasper D., 2d.** *Donacia emarginata*, a Holocene long-horned leaf beetle from Milburn, Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 14, 1970.

02683 **Skipper, Keith.** Antidune cross-stratification in turbidite sequence, Cloridorme Formation, Gaspé, Quebec [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 871, 1970.

02772 **Slaughter, A. L.** The Homestake mine, *in* Guidebook and road logs for 23d Ann. Mtg., Rocky Mtn. Sec., Geol. Soc. America, Rapid City, S. Dak., 1970: Rapid City, S. Dak., South Dakota School Mines and Technology, Dept. Geology and Geol. Eng., p. 7-8, illus., 1970.

The Homestake Formation of sideroplesite schist overlies the Poorman Formation, the oldest of the Precambrian metasediments in the northern Black Hills schist area near Lead, and underlies the Ellison Formation. Above these three formations are the Northwestern, Flagrock and Grizzly argillaceous formations. The Cambrian Deadwood Formation unconformably overlies the Precambrian rocks. Tertiary dikes, sills and stocks cut the Precambrian and Cambrian rocks. The Homestake mine ore bodies are more or less completely chloritized portions of the cummingtonite, or sideroplesite schist of the Homestake Formation, with abundant veins and masses of quartz and some pyrrhotite, pyrite and arsenopyrite. Four stages of hydrothermal mineralization are recognized. — EH

02849 **Smedes, Harry W.** Program statement for regional geologic studies in remote sensing, Yellowstone National Park, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 15-1 — 15-9, table [1970].

The Yellowstone project (test site 11) was initiated in 1965 for the dual purpose of studying the geologic history and structural relations of rocks and surface deposits and of evaluating a wide variety of remote-sensing data in terms of geologic information. Mapping and five reports were completed or are in progress on various aspects of the geology of the national park and on interpretation of the imagery. A few of the important findings are summarized and a description of the missions and sensors used is shown in tabular form. Current work, using multisensors, has disclosed anomalies and false recognitions. Parameters, such as slope, moisture, and texture, which affect these recognitions, must be determined. — EH

02949 **Smellie, Donald W.** Base metal exploration in the Cordillera [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 345-349, illus., 1970.

In the Cordilleran region geophysical methods have been employed in the following varieties of massive sulfide exploration: (1) thick tabular deposits, as in the Anvil-Vangorda area, Yukon, where helicopter magnetic and EM surveys have been used for preliminary reconnaissance followed up on ground with magnetic, EM, SP, and gravity surveys; (2) vein deposits, where the EM method has been used extensively; and (3) pyrometasomatic deposits, as at Pima, Ariz., where magnetic and electromagnetic methods have been important; in the latter case, more extensive disseminated mineralization was subsequently discovered. Detection of vein-type mineralization has also led to discovery of extensive disseminated mineralization. — *from* Author's abstract

02347 **Smith, Derrell A.; Reeve, F. A. E.** Salt piercement in shallow Gulf Coast salt structures: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1271-1289, illus., table, 1970.

Data from 16 Gulf Coast salt structures document piercement features and suggest mechanisms and controls of the piercement process. Piercement by rupture and upward and outward tilting of overburden sediments with rise of salt enhanced by erosion is most likely in early stages of salt dome growth. Piercement by vertical displacement of overburden ahead of the growing salt mass with peripheral faulting is most likely when the salt has a plug shape and grows by plug flow; this can result in discordant relations between the plug and enveloping strata. These relations can occur contemporaneously with or after deposition of overburden. Vertical displacement of overburden as much as 2,400 feet thick can be documented. — EGS

02684 **Smith, Donald L.; Garrett, Peter; Patriquin, David; Wilson, Augustus O.** Physiography, ecology, and sediments of two Bermudan lagoon reefs [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 871, 1970.

02257 **Smith, Douglas.** Stability of iron-rich orthopyroxene: Carnegie Inst. Washington Year Book 68, 1968-69, p. 229-231, illus., 1970.

Smith, J. V. *See* Moore, P. B. 02870

02728 **Smith, R. M.; Twiss, P. C.; Krauss, Roland K.; Brown, Merle J.** Dust deposition in relation to site, season, and climatic variables: Soil Sci. Soc. America Proc., v. 34, no. 1, p. 112-117, illus., tables, 1970.

Mean monthly dust deposition into standard traps for 14-37 months at 14 locally nondusty sites east of the Rocky Mountains ranged from 17-459 kg/ha. Correlation analyses showed positive relations with wind velocities either near the stations or for western Kansas. Rainfall parameters also tended to correlate positively with dust catch at most stations. Significant differences in dust quality measures as well as in rates were demonstrated. — Soil brief

02352 **Smith, Robert B.** Regional gravity survey of western and central Montana: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1172-1183, illus., 1970.

Data from more than 2,700 gravity stations was interpreted by automated computer techniques. The Bouguer gravity anomaly map shows a large northwest-trending low of -175 mgal across the Montana Rockies fold-and-thrust belt, two northwest-trending zones, one in the Lewis Thrust and the other east of the Disturbed Belt in which values increase sharply eastward, and an increase in values eastward into the Great Plains to more than -55 mgals. Positive residual anomalies may reflect igneous ridges at top of basement, near-surface intrusive bodies, and uplifted crustal blocks. Significant negative residual anomalies may represent structural basins. The general northeast trend of regional anomalies suggests relations to pre-Paleozoic structural grain of southern Canada and north-central United States. — *from* Author's abstract

02354 **Smith, Ronald E.** Guide for depth of foundation exploration: Am. Soc. Civil Engineers Proc., v. 96, paper 7120, Jour. Soil Mechanics and Found. Div., no. SM2, p. 377-384, illus., table, 1970.

A procedure for rapidly determining the depth of exploration beneath a foundation system is presented. The determined depth is based on a widely used settlement criterion and the Boussinesq stress distribution. A single chart is used for surface foundations, whereas embedded foundations require the same chart plus a few simple calculations. The paper was prepared primarily for the benefit of young, inexperienced engineers to provide a sound basis for determining critical depth of exploration. — ASCE abstract

Snavely, Parke D., Jr. *See* MacLeod, Norman S. 02948

02761 **Sneath, P. H. A.** Planets and life: New York, Funk and Wagnalls, 216 p., illus., 1970.

02500 **Snow, C. Bruce.** Stratigraphy of basal sandstones in the Green River Formation, northeast Piceance basin, Rio Blanco County, Colorado: Mtn. Geologist, v. 7, no. 1, p. 3-32, illus., 1970.

In Tertiary outcrops on the northeastern rim of Piceance basin, the Anvil Points Member of the Green River Formation overlies the Wasatch Formation; it has a northward thickening sandstone facies deposited at the shoreline of Lake Uinta, and a younger siltstone of prolonged offshore sedimentation. Oil-field logs show subsurface Wasatch increasing westward as paludal-lacustrine deposits. The gas-bearing Douglas Creek Member, equivalent to Anvil Points sandstone and of diverse lithology, thickens northeastward. Overlying shales of Garden Gulch Member, time-equivalent of Anvil Points siltstone, reflect a lake stillstand. Supersedent deep-water

oil shales were deposited when the lake expanded past the present structural basin. Hydrocarbons in these units are probably derived from organic paludal-lacustrine deposits; the Wasatch in the central basin is the most promising for petroleum. — GDC

02433 **Snow, D. T.; Meidav, Tsvi; Ehrlich, Marvin.** Prediction of seepage to limestone quarry by geophysical and hydrogeological techniques [abs.]: Mining Eng., v. 22, no. 1, p. 44, 1970.

02897 **Soderman, L. G.; Kim, Y. D.** Effect of groundwater levels on stress history of the St. Clair clay till deposit [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 173-187, illus., table, 1970.

Over 100 feet (30.4 m) of relatively homogenous and compressible lacustrine clay and clay till deposits cover a large portion of the St. Clair basin in southwestern Ontario. The deposit is considered to be normally consolidated at depth with an overconsolidated crust caused by desiccation and weathering. Based on data from recent laboratory one-dimensional consolidation tests and evidence of a lowered groundwater level in the past, it can be shown that the St. Clair clay till deposits are lightly overconsolidated at depth, with a heavily overconsolidated crust in the upper 40 feet of the deposit. The evidence of a higher degree of overconsolidation can be used to explain the large discrepancies between predicted and observed settlements of structures founded on the St. Clair clay till. — Author's abstract

02459 **Sommerfeld, R. A.; LaChapelle, E.** The classification of snow metamorphism: Jour. Glaciology, v. 9, no. 55, p. 3-17, illus., 1970.

A new classification of snow on the ground is based on the major physical processes involved in the metamorphism of a snow cover. The major divisions are based on (1) the mechanical damage to snow crystals during precipitation, (2) the transport of water vapor at constant temperature because of surface-energy differences, (3) the transport of water vapor along a thermal gradient, and (4) firnification because of melting and refreezing, and pressure consolidation. — Authors' abstract

02685 **Sorauf, J. E.** Microstructure of rugosan skeleton (Coelenterata) [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 871, 1970.

02269 **Spannagel, Gert; Fireman, Edward L.** Radioactivities in the Lost City meteorite — A cosmic-ray space probe [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

02686 **Spencer, Derek W.; Koons, C. B.** Studies on origin of crude oil — Statistical analyses of crude oil data [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 871, 1970.

Sproll, Walter P. *See* Dietz, Robert S. 02490

02455 **Stanley, Edward A.** The stratigraphical, biogeographical, paleoautecological, and evolutionary significance of the fossil pollen group Triprojectacites: Georgia Acad. Sci. Bull., v. 28, no. 1, p. 1-44, illus., 1970.

The fossil pollen genus *Aquilapollenites* Rouse and closely related form genera have been the topic of several publications within the last several years. Part of the reason for the widespread interest in these plant microfossil taxa is that they are both stratigraphically and geographically restricted, and their distribution in both time and space permits theorization on such important topics as vegetational zonation and the establishment of floral provinces for the Late Cretaceous Period. In addition, the group is morphologically unique, and this factor coupled with its rapid evolution of species makes *Aquilapollenites* and closely related forms important index fossils for the Upper Cretaceous. — *from* Author's introduction

Stark, Philip H. *See* Forgotson, James M., Jr. 02618

02687 **Steick, C. R.** Cretaceous deltas, Alberta [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 871-872, 1970.

02402 **Stephens, D. R.; Lilley, E. M.; Louis, H.** Pressure-volume equation of state of consolidated and fractured rocks to 40 kb: Internat. Jour. Rock Mechanics and Mining Sci., v. 7, no. 3, p. 257-296, illus., tables, 1970.

A rapid and accurate method to obtain pressure-volume data to 40 kb at 25°C for rocks is presented. Typical data for both consolidated and artificially fractured materials are included. Pressure-volume curves so obtained can be related to initial porosity of the consolidated rock and to porosity induced by fracturing test samples. Qualitative features of the pressure-volume curves are consistent with a model of the effect of porosity on compressibility. Experimental results may be related to the *in situ* elastic properties of rock. These data, together with other mechanical properties, are used for numerical calculations of effects of explosions in rock. Several nuclear explosions and high-explosive detonations in the Plowshare Program of the AEC have been successfully calculated using this type of data. — *from* Authors' abstract

02688 **Stevens, Calvin H.** Geometry of Inyo-White Mountains allochthon, eastern California [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 872, 1970.

Stevens, D. N. *See* DeVoto, R. H. 02556

02535 **Stevenson, T. H.** The search for the Yarmouth in the valley of the ancient Platte [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 37, 1970.

Stewart, J. M. *See* Donnay, Gabrielle. 02708

02947 **Stewart, J. W.** Use of remote sensors in classifying lakes in west-central Florida, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 3, Hydrology, oceanography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 22B1-22B11, illus. [1970].

The purpose of this study of an area in west-central Florida was to apply remote-sensing techniques to problems of lake hydrology by defining parameters as a basis for classifying lakes in a karst topography, classifying shoreline features of lakes as a means of establishing high-water marks significant to the hydrology of the area, and determining the interrelationship between classes of lakes, their occurrence and effects on the hydrologic regimen. Data from a February 1968 mission, which used infrared imagery, color infrared and black-and-white photography, were evaluated in terms of specific classification features, many of which were easily distinguishable. The application of sensors appears to offer great potential for rapid appraisal of lake hydrology for large areas, as well as for small problem areas. — EH

02400 **Stewart, John H.; Albers, John P.; Poole, Forrest G.** Summary of regional evidence for right-lateral displacement in the western Great Basin — Reply [to discussion by L. A. Wright; B. W. Troxel, 1970, of 1968 paper]: Geol. Soc. America Bull., v. 81, no. 7, p. 2175-2179, illus., 1970.

Precambrian to Mesozoic sedimentary trends have a pattern of sigmoidal bending and apparent disruption in the southern Great Basin which the above authors interpret as resulting from right-lateral shear. Wright and Troxel (ibid., p. 2167-2173) question this because their evidence indicates little lateral displacement there. Their conclusion of little offset is questioned here. It is agreed, however, that there is a lack of firm structural evidence for sizable right-lateral shear in the Black Mountain block, an unresolved difficulty with the large displacement concept. — *from* Authors' conclusions

02973 **Stewart, Robert A.** Palynology of some early Tertiary deposits in northeastern Mississippi [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 23, 1970.

Stone, David B. *See* Cameron, Christopher P. 02776

02735 **Stone, W. J.** Stratigraphic significance of fossil rhinoceros remains in Slope County, North Dakota [abs.]: North Dakota Acad. Sci. Proc., v. 24, pt. 1, p. 32, 1970.

02536 **Stout, Thompson M.** A new approach to intercontinental correlations [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 37, 1970.

Stradling, Dale. *See* McKee, Bates. 02392

02915 **Strange, W. E.** The use of gravimeter measurements in mining and groundwater exploration [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 46-50, 1970.

Improvements of land gravimeters provide data of increased accuracy in conjunction with decrease in time, effort, and cost. New instruments make possible execution of special work such as gravity-gradient, three dimensional mine, and offshore gravity surveys. Gravimeters for moving platforms present problems, those for shipboard use are progressing, and airborne systems are in the experimental stage. The borehole gradiometer offers promise for providing porosity estimates in ground-water and density estimates in mining studies. Computerized field-data handling permits rapid data plotting and contouring, swift and accurate reductions including terrane correction, and processing of information from other sensors in the case of moving platform systems; this handling is grouped into: separation of local and regional anomalies and fitting of density models to explain observed gravity field. A number of techniques for resolving these problems are available. — *from* Author's abstract

02918 **Strangway, D. W.; Vozoff, K.** Mining exploration with natural electromagnetic fields [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 109-122, illus., 1970.

Natural EM fields, long a source of interference in magnetic and electrical surveys, have become the basis for at least three exploration techniques: AFMAG, tellurics, and magnetotellurics. Difficulties are found when attempting to apply these methods due to the weakness and variability of the fields. Useful results are being obtained, but for maximum effectiveness the true complexity of the relationships between primary magnetic fields and their induced currents must be taken into account. New techniques of interpretation, and improved instrumentation, are permitting more effective use of these methods than has been possible previously. It appears they will be of major use to mining exploration in areas of high background resistivity and deeply buried sulphide bodies. — Authors' abstract

02495 **Strimple, Harrell L.** The occurrence of *Onychaster strimplei* in Oklahoma: Oklahoma Geology Notes, v. 30, no. 2, p. 42, 1970.

Discovery of a specimen of *Onychaster strimplei* Bjork, Goldberg, and Kesling (1968), in material excavated during the spring of 1969 near Vinita, Craig County, Okla., is considered significant as the occurrence of ophiuroids in Oklahoma does not appear to have been previously recorded. The exposure is a dark shaly facies of the Fayetteville Formation, the type locality for other species (herein listed). Although the fauna is not identical with that reported from near Anna, Ill., a very close relationship is readily apparent. – MCM

Strimple, Harrell, L. *See* Pabian, Roger K. 02533

02987 **Sturgul, John R.; Irwin, Thomas D.** Earthquake history of Arizona and New Mexico, 1850-1966 [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 67, 1970.

02537 **Suhm, Raymond W.** Members of the Everton Formation (early medial Ordovician) in northern Arkansas [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 38, 1970.

02959 **Sumner, John S.** Geophysical aspects of porphyry copper deposits [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 322-335, illus., table, 1970.

Porphyry copper deposits have a general range of physical properties which guides exploration procedures. In southwestern North America, regional geophysical studies can locate broad linear structures and favorable ore environments; in a global sense, the world's occurrences appear to be related to structures of the type associated with midoceanic ridges. Most geophysical methods are indirect in application to discovery of porphyries, but they supply important information about related structure and lithology. IP surveying often directly indicates presence of even weak

sulfide mineralization, making it a popular geophysical tool. An integrated program of several geophysical methods with strong geological and mining assistance appears to be the search procedure in most common use. — *from* Author's abstract

Sun, Meng-Cherng. *See* Wang, Fun-Den. 02439

02922 **Sutherland, Don B.** AFMAG for electromagnetic mapping [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 228-237, illus., 1970.

The main advantage of the AFMAG method over conventional 2-coil electromagnetic systems is its inherently greater range; naturally occurring fields in the AF range are utilized and their nature is briefly reviewed. Ground apparatus, providing extended range with lightweight equipment, is well suited for reconnaissance surveying since data indicate direction and often strike of the conductor disturbing the field. As an airborne system, AFMAG is virtually independent of aircraft used. Many major fault and shear zones give rise to strong AFMAG anomalies easily recognized from airborne results. Limitations of the method are chiefly the restricted period of useful measurements which is most pronounced in high latitudes and reduced response from conductors lying parallel to strongly oriented regional fields; the latter cannot be overcome but can be minimized by proper choice of direction of measurement. — *from* Author's abstract

02779 **Sutton, George H.; Odegard, Mark E.; Mark, Norman; Letourneau, Nelson J.** Research in seismology related to the Columbia ocean-bottom seismograph — AFCRL Contract F19628-68-C-0083, Final Rept.: Hawaii Inst. Geophysics [Rept.] HIG-70-12 (AFCRL-70-0125), 66 p., illus., 1969 [1970].

The report describes the history of the Columbia Ocean-Bottom Seismograph, location and instrumentation of OBS-III, nature of research conducted under this contract and personnel associated with it. Results of research in the areas of spectral and correlation analysis, local earthquake studies, particle motion studies, detection ability studies, construction of a station log of events, microseism analysis, and studies of interesting arrivals in local earthquake wave trains are outlined. Suggestions are made for further research. — *from* Authors' abstract

Sweet, Palmer C. *See* Johnson, Stanley S. 02781

02689 **Swinchatt, Jonathan P.** Sedimentary and faunal associations of protected carbonate shelves and platforms [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 872, 1970.

Swindale, L. D. *See* ElSwaify, S. A. 02383

Swindale, L. D. *See* El-Swaify, S. A. 02547

Syers, J. K. *See* Mokma, D. L. 02545

02960 **Tackett, Stanford L.; Ong, Patricia T.** Polarographic determination of cobalt and nickel in iron meteorites: Anal. Letters, v. 3, no. 4, p. 169-175, illus., tables, 1970.

Cobalt and nickel were determined in five iron meteorites [Canyon Diablo, Huizopa, St. Genevieve County, Arispe, Santa Rosa] by a polarographic method. The analyses gave good precision and are believed to be reliable. The nickel content ranged from 6.49 percent to 8.07 percent, and cobalt ranged from 0.4 percent to 0.49 percent. Atomic absorption measurements were made on the sample solutions for comparison. — Authors' abstract

Tailleur, Irvin L. *See* Brosgé, William P. 02592

Takahashi, T. *See* Mao, H. K. 02254

Takahashi, T. *See* Mao, H. K. 02255

Takahashi, Taro. *See* Mao, H. K. 02812

Tamura, Tsuneo. *See* Francis, C. W. 02553

02830 **Tank, Ronald W.** Ventifacts associated with the Cambrian-Precambrian unconformity at Nekoosa, Wisconsin: Wisconsin Acad. Sci., Arts and Letters Trans. 1970, v. 58, p. 147-151, illus., 1970.

This paper reports on occurrences of ventifacts in the exposure of the Cambrian-Precambrian unconformity at Nekoosa, Wis. Ventifacts, which can be indicators of prolonged wind erosion, were also found at Crivitz and Chippewa Falls, but were not found at every exposure of the unconformity. Two vein quartz ventifacts were found *in situ* at the contact between pebble conglomerates, at the base of the Cambrian Dresbach sands, and the highly-altered clayey schist of Precambrian age. The unconformity corresponds to a "high-continentality" in late Precambrian time. The occurrence of ventifacts at the top of this erosion surface indicates that during late Precambrian wind erosion was an active agent in Wisconsin. — EH

02538 **Tanner, Lloyd G.** Notes on the genera *Aphelops* and *Peraceras* with a suggested tribal classification [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 38, 1970.

02258 **Taylor, L. A.; Kullerud, G.** The system Cu-S-O: Carnegie Inst. Washington Year Book 68, 1968-69, p. 273-276, illus., 1970.

02259 **Taylor, L. A.** Low-temperature phase relations in the Fe-S system: Carnegie Inst. Washington Year Book 68, 1968-69, p. 259-270, illus., tables, 1970.

02410 **Tchalenko, J. S.** Similarities between shear zones of different magnitudes: Geol. Soc. America Bull., v. 81, no. 6, p. 1625-1639, illus., tables, 1970.

Shear zone structures were examined on three scales: (1) microscopic, in shear box test; (2) intermediate, in Riedel experiment; (3) regional, in earthquake fault zone. Three stages were studied: the structure at peak shearing resistance, the post-peak structure, and structure at residual shearing resistance. Similarities in structure occurred at each stage, and most could be interpreted in terms of the mechanical properties of the material, Coulomb failure criterion, and kinematic restraints inherent in type of deformation. Similarities, such as relative dimensions of structures, spacing of shears, and "Riedel within Riedel" structures have not been explained. — RAL

02425 **Teague, Kefton H.** Evaluation of feldspar deposits [abs.]: Mining Eng., v. 22, no. 1, p. 40-41, 1970.

02756 **Techter, David.** Stereogram book of rocks, minerals and gems: Northbrook, Ill., Hubbard Press, 64 p., illus., 1970.

02578 **Thayer, Paul A.** Geology of Davie County Triassic Basin, North Carolina: Southeastern Geology, v. 11, no. 3, p. 187-198, illus., tables, 1970.

Upper Triassic nonmarine strata are in two intertonguing facies: (1) basin margin polymict conglomerate, and (2) basin center sandstone-siltrock-clayrock. The conglomerate facies, interpreted as an alluvial fan, is thick-bedded, crudely stratified, and contains sandstone lenses that display cut-and-fill, and large-scale trough cross-bedding. The basin center facies exhibits fining-upwards cycles and is considered to be fluvial in origin. Medium- and coarse-grained, poorly-sorted plagioclase arkoses and lithic arkoses grade upward through a decrease in grain size and bed thickness into massive-appearing maroon mudrocks. Sandstone mineralogy, clast petrology, and lithofacies distribution indicate the basin was filled from the eastern and western sides, mainly from nearby medium to high-rank metamorphic sources. — *from* Author's abstract

Theyer, Fritz. *See* Morin, Robert. 02795

Thomas, C. W. *See* Young, J. A. 02507

02690 **Thomas, Carroll M.** Petrology of Pennsylvanian carbonate bank and associated environments, Azalea field, Midland County, Texas [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 872-873, 1970.

02345 **Thomas, W. A.** Arthur Henry Petsch (1895-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1310, portrait, 1970.

Thompson, Gary G. *See* Cross, Aureal T. 02601

02964 **Thompson, Geoffrey; Bankston, Donald C.** Sample contamination from grinding and sieving determined by emission spectrometry: Appl. Spectroscopy, v. 24, no. 2, p. 210-219, tables, 1970.

Trace-element contaminations, introduced by grinding or sieving Specpure samples of silica and calcium carbonate in various common devices, were measured using emission spectrometry. The tungsten carbide vial introduced large amounts of Co and Ti; the alumina mortar, Al, Cr, Fe, Ga and Zr; the alumina-ceramic vial, 12 trace elements. The boron carbide mortar (except for B), agate mortar, and Lucite grinding vials introduced little or no contamination, as did sifting with nylon sieves. Stainless steel or brass sieves introduced appreciable levels of trace metals. Pregrinding an aliquot of the sample is recommended; greater reductions in contamination were noted by grinding with soft fine $CaCO_3$ than with SiO_2. Cross contaminants from previously ground samples were better removed by grinding with the hard, more abrasive SiO_2. — *from* Authors' abstract

Thompson, Margaret D. *See* Burger, H. Robert, 3d. 02376

02341 **Thompson, Wallace C.** Thornton Davis (1892-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1307-1308, portrait, 1970.

Thomson, Alan. *See* McBride, Earle F. 02309

Thomson, F. H. *See* Boswell, E. H. 02765

02287 **Thomson, Kenneth C.** Deep Creek Mountains, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 29, 1970.

In the Deep Creek Mountains, biotite granite of the Ibapah stock intrudes sedimentary rocks ranging in age from Precambrian through Triassic. K-Ar ages of 22 m.y. on the Ibapah stock, and 17.7 ± 0.9 m.y. on muscovite associated with beryllium mineralization suggests that the Pb-α age of 71 m.y. on zircon from granite is erroneous. — MCM

02952 **Thomson, S.** Riverbank stability study at the University of Alberta, Edmonton [with French abs.]: Canadian Geotech. Jour., v. 7, no. 2, p. 157-168, illus., table, 1970.

The need for new building sites at the University of Alberta required an investigation of the stability of the valley wall of the North Saskatchewan River within the campus limits. A geologic map and stratigraphic sections which were drawn show Upper Cretaceous shales and sandstones overlain by preglacial sands and gravels which are overlain by till and glacial lake sediments. A large, buried preglacial valley on the western side of the study area enhances slope stability because it lowers the piezometric surface. Landslide analyses indicate that effective strength parameters near peak values are being mobilized. On the eastern side of the study area old landslides are revealed by subdued slump topography. Residual strength parameters used in an infinite slope analysis result in low factors of safety. — Author's abstract

Thurber, Horace K. *See* Irwin, William P. 02334

Tieh, Thomas T. *See* Pyle, Thomas E. 02442

02691 **Tillman, R. W.** Discriminant analysis versus factor analysis of grain-size data from different environments and sedimentary structures [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 873, 1970.

02692 **Tissot, B. P.** Present knowledge of fundamental processes of oil and gas origin and migration applied to petroleum prospecting [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 873, 1970.

Toebes, G. H. *See* Chang, T. P. 02715

Toksöz, M. Nafi. *See* Shlien, Seymour. 02303

02292 **Toomey, Donald Francis; Mamet, B. L.** Annotated bibliography of Paleozoic nonfusulinid Foraminifera, Addendum 7: Cushman Found. Foram. Research Contr., v. 21, pt. 2, p. 50-70, 1970.

This addendum includes 109 annotated references pertaining to Paleozoic nonfusulinid Foraminifera, and can be considered reasonably complete through the year of 1968. As in previous bibliographies, (Toomey, 1959, 1961, 1963, 1965, 1966, and Toomey and Mamet, 1967, 1968 and 1969), the aims are unchanged: (1) to summarize briefly the pertinent data contained in each article, (2) to list all new genera and species described therein, and (3) to denote, within brackets, all taxonomic changes noted from current and subsequent publications, and to include pertinent comments when possible, thus making the bibliography a more useful working tool. — Authors' abstract

Tracey, Joshua I., Jr. *See* Oriel, Steven S. 02318

Trautz, Otto R. *See* LeGeros, Racquel Z. 02803

Trautz, Otto R. *See* Klein, Edward. 02878

02349 **Travis, Russell B.** Nomenclature for sedimentary rocks: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1095-1107, illus., 1970.

A systematic deviation of names for sedimentary rocks composed of mixtures of mechanical or chemical fractions is formulated. Proposed are two new terms — "aggregal" and "integral" referring to rock texture. It is further suggested that the term "acretic" be used as the textural subdivision of aggregal rocks. A nomenclature chart outlining the proposed system is included. — JKP

02418 **Trescott, Peter C.; Pinder, George F.** Air pump for small-diameter piezometers: Ground Water, v. 8, no. 3, p. 10-15, illus., 1970.

The engine of a field vehicle can be used as an air pump by inserting a commercially manufactured check valve into a spark-plug socket; small-diameter piezometers can be pumped with compressed air from this source. With sufficient air-line submergence, the method can be used to pump 1-in diameter piezometers where pumping lift is less than 70 feet and 1.25-in diameter piezometers where pumping lift is less than 50 feet. In cases where this method will not work, some water contained in the piezometer can be pumped out by pressurizing the piezometer if formation transmissivity is low and pumping lift is not excessive. Maximum pumping lift is a function of rate at which pressure in the piezometer is increased and rate at which water flows into the formation with an increasing head in the piezometer. The engine air pump is useful in developing piezometers, flushing out stagnant water before taking water samples, obtaining water samples, and creating head differences to initiate slug tests. — *from* Authors' abstract

Trollope, D. Hugh. *See* Brown, Edwin T. 02359

02510 **Trowell, N. F.** Bell Lake-Sturgeon Lake area, Districts of Kenora and Thunder Bay: Ontario Dept. Mines Prelim. Geol. Maps P. 588, 589, 590, 591, scale 1 in. to 1/4 mi., text, 1970.

The map area is covered by four sheets (588, northwest; 589, northeast; 590, southwest; 591, southeast); the same text is printed on all sheets. The Bell Lake-Sturgeon Lake area is underlain by Keewatin-type metavolcanics and Timiskaming-type metasediments; bedrock is extensively overlain by glacial deposits and recent swamp accumulations. Regional foliation of Precambrian rocks is steeply dipping and trends NE-ENE; other foliations are probably due to minor shearing, cross folding, and faulting. Exploration indicates some gold, copper, molybdenum, zinc, and precious metals mineralization. — MCM

Troxel, Bennie W. *See* Wright, Lauren A. 02399

02720 **Tryggvason, E.; Qualls, B. R.** Seismic refraction measurements of crustal structure in Oklahoma: Shale Shaker, v. 20, no. 9, p. 174-175, illus., 1970.

A deep seismic profile was shot in 1964 between a point near Chelsea in northeastern Oklahoma and one near Manitou in southwestern. Analysis of recordings made at 35 sites and at seismological observatories in the state, indicates that the Earth's crust consists of laterally homogenous layers separated by discontinuities. The M-discontinuity dips gently towards the southwest, and crustal thickness is 1.2 km greater at the southwestern than at the northwestern end of the profile. Total crustal thickness along the profile is 50.9 km, assuming horizontal beds. The upper mantle velocity of 8.32 kmps is rather high and the mean P-wave velocity, 6.6 kmps, is very high. — EH

02839 **Tully, Philip C.; King, Billy Joe; Dowdy, Emily.** Helium — Bibliography of technical and scientific literature, 1963, including papers on alpha-particles: U.S. Bur. Mines Inf. Circ. 8467, 831 p., 1970.

Occurrences of helium and alpha particles in meteorites, minerals, and natural gases are represented by 3,062 references. — APB

02864 **Tunny, J.** The influence of Saran Resin coatings on swelling of natural soil clods: Soil Sci., v. 109, no. 4, p. 254-256, tables, 1970.

The flexibility of Dow Saran Resin F-220 for coating natural soil clods was examined. It was found that five coats of 1:7 saran resin considerably inhibited the swelling of natural soil clods. Significant differences in bulk density measurements also indicate that saran resin may not contract with the clod as volume decreases on drying. — *from* Author's summary

Turcotte, D. L. *See* Oxburgh, E. R. 02369

Turk, L. J. *See* Flawn, Peter T. 02784

02416 **Tweto, Ogden; Bryant, Bruce; Williams, Frank E.** Mineral resources of the Gore Range-Eagles Nest Primitive Area and vicinity, Summit and Eagle Counties, Colorado: U.S. Geol. Survey Bull. 1319-C, p. C1-C127, illus., tables, geol. map, 1970.

The Gore Range is a fault block of Precambrian rocks between the Gore fault on the west and the Frontal fault on the east; the block is broken by many faults. Uplift began very late in geologic time and continues to the present. The mineral potential of the Primitive Area was studied by examination of records of mining activity and mineral production, by study of the geology in relation to that of nearby productive areas, by exploration for signs of mineral deposits, and by a program of sampling and detailed analysis both of rocks and of sediments in streams. The area contains no known ore deposits; there is no geologic evidence indicating a likelihood of hidden deposits, even though many fractures are geochemically anomalous. There is no potential for coal, oil, or gas, and practically none for nonmetallic minerals. — *from* Authors' abstract

Twiss, P. C. *See* Smith, R. M. 02728

02474 **Uchida, Kinsuke; Ichisugi, Norio; Aratake, Nagaharu; Shigeno, Saburo.** Application of two-dimensional trend surface analysis for the ore reserve estimation at Lor-

nex mine, B.C., Canada [in Japanese, with English abs.]: Mining Geology, v. 20 (2), no. 100, p. 92-105, illus., tables, 1970.

This analysis was applied to assign a copper grade to unit ore blocks, mainly to examine the ore reserve calculation from an investor's point of view. The ore deposit was divided at 80-ft E-W intervals into 29 longitudinal slices nearly parallel to the N-S fissure system described in a feasibility report as strongly governing trend in distribution of copper and molybdenum grades. The 87 drill-holes, 66 within the pit limit, seem small for an ore body with reported reserves of 294 million short tons, but the result obtained by the method described was only slightly larger in tonnage and lower in grade at the same cutoff. The reason for the difference may be that high-grade intersections tend to be smoothed off in the trend surface analysis. The computed trend indicated an aggregate of three lenticular high-grade blocks en echelon. — GDC

Updegrove, W. S. *See* Levy, Ram L. 02737

02775 **U.S. Coast and Geodetic Survey.** Isogonic chart for the United States (and Alaska and Hawaii), 1970.0 (lines of equal magnetic declination and equal annual change): Washington, D.C., U.S. Dept. Commerce, scale 1:5,000,000, revised 1970.

02841 **U.S. Natl. Aeronaut.and Space Adm.** Earth resources aircraft program status review, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, papers paged separately, illus., tables [1970,].

This volume contains 21 papers (16 cited separately) which were presented at the NASA Manned Spacecraft Center in Houston, Texas, September 16-18, 1968. They cover applications of remote-sensing techniques and sensors to the analysis of land use, resources, urban areas, geology and hydrology. Progress reports on improvements in methods and instrumentation are included. — EH

02693 **Vacher, H. Leonard; Mackenzie, Fred T.** Pleistocene calcarenite lithosomes of Bermuda [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 873-874, 1970.

Valencia, Mark J. *See* Leffingwell, Harry A. 02297

02351 **Vandorston, P. L.** Environmental analysis of Swan Peak Formation in Bear River Range, north-central Utah and southeastern Idaho: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1140-1154, illus., 1970.

The Swan Peak Formation (Middle Ordovician), 0 to 400 feet thick, consists of a lower unit of quartzite shale and limestone which accumulated in a shallow-shelf environment; a middle unit of quartzite and shale representing shoreface, tidal-flat, and lagoonal environments; and upper units of quartzite, probably a shallow marine sandstone deposited by south-flowing currents. Lower and middle units are progradational, formed during marine regression at the end of the Sauk sequence. Sources for much of the sand lay northward in Idaho. "Fucoidal markings" in the middle unit appear to be feeding burrows filled with organically reworked sediment. — EGS

02993 **Vice, Daniel H.** The geology of the Babocomari Ranch in Cochise-Santa Cruz Counties, Arizona [abs.]: Arizona Acad. Sci. Jour., v. 6, 1970 Proc. Supp., p. 67, 1970.

Vincent, Edith. *See* Morin, Robert. 02795

02694 **Visher, Glenn S.; Saitta-Bertoni, Sandro; Phares, Roderick S.** Pennsylvanian delta patterns and oil occurrences in eastern Oklahoma [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 874, 1970.

Vogan, R. W. *See* Quigley, R. M. 02902

02361 **Voight, Barry; Pariseau, William.** State of predictive art in subsidence engineering: Am. Soc. Civil Engineers Proc., v. 96, paper 7187, Jour. Soil Mechanics and Found. Div., no. SM2, p. 721-750, illus., tables, 1970.

Existing methods of predicting ground motion due to mining are reviewed and evaluated. Foundation design could not proceed without an estimation of surface displacements and strains due to subsidence. Consideration is given to the prediction and alleviation of subsidence damage. Finally, important lessons from the extensive experience of foreign subsidence engineers are summarized. Techniques currently available for subsidence investigations are reviewed, and the course that future research should take is outlined. — ASCE abstract

Vozoff, K. *See* Strangway, D. W. 02918

02576 **Waddell, Galen G.** Progress on techniques of investigating and controlling rock bursts: Soc. Mining Engineers AIME Trans., v. 247, no. 2, p. 186-192, illus., table, 1970.

Several years of rock-burst research conducted by the U.S. Bureau of Mines in cooperation with the mining companies of the Coeur d'Alene mining district, Idaho, in addition to progress made by others throughout the world, have led to a good understanding of the rock-burst problem. This paper describes conditions which have caused specific bursts, present capabilities of detecting stress buildip and bursts, control methods, and a suggested approach to analyzing any individual mine-burst problem. It describes a simple seismic system to monitor local and regional rock bursts and to designate the mines from which they originate, a more complex seismic network to locate bursts within a mine accurately, and a microseismic network to pinpoint sources of acoustic emission associated with stressed rock preceding bursts. — *from* Author's abstract and summary

02427 **Wagner, Richard J.** Geology and zonation of the southeast Missouri barite district [abs.]: Mining Eng., v. 22, no. 1, p. 41, 1970.

02970 **Waldrop, Lyneve.** The crystal structure of triploidite and its relation to the structures of other minerals of the triplite-triploidite group [with German abs.]: Zeitschr. Kristallographie, v. 131, nos. 1-2, p. 1-20, illus., tables, 1970.

Crystal structure of triploidite from Branchville, Conn., was found to be based on a triplite substructure. A Fourier synthesis of the substructure suggested a beginning model. Three-dimensional least-squares refinement reduced the discrepancy index from 39 percent to 5.7 percent for 769 measurable reflections. The triplite-triploidite group can be divided into two subgroups of isotypic minerals — one containing triplite-zwieselite, the other composed of triploidite-wolfeite, wagnerite, and probably sarkinite. Primary differences between triplite and triploidite structures lie in ordering of F,OH sites and in small shifts in atomic positions. Coupling of differences gives rise to a change in environment of F,OH sites which probably allows repulsion between metal and OH-hydrogen atoms to be reduced in the triploidite structure. — *from* Author's abstract

02695 **Walker, Roger G.; Harms, J. C.** Thin marine-nonmarine alternations in Upper Devonian "Catskill delta" [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 874, 1970.

02696 **Walker, Roger G.; Pettijohn, F. J.** Archean turbidite basin, northwestern Ontario [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 874, 1970.

Wallace, H. *See* Wolfe, W. J. 02516

Wallace, H. *See* Wolfe, W. J. 02734

02267 **Walter, Louis S.; Doan, Arthur S., Jr.** Mineralogy of the Lost City meteorite [abs.]: EOS, v. 51, no. 7, p. 581, 1970.

02818 **Wang, Chi-Yuen.** Can mantle minerals have the NiAs structure?, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 213-217, 1970.

From the point of view of crystal chemistry, the nature of the chemical bonds in the NiAs structure is examined in an attempt to offer some criteria for the possible correctness of the prediction that this structure may be an important structure for mantle minerals. It is concluded that the nontransition-metal minerals will not have the NiAs structure; on the other hand, the possibility cannot be excluded that iron oxides may assume this structure at great depth. A number of geophysically interesting implications may arise if iron oxides have the NiAs structure in the lower mantle. A definite answer for the geophysical significance for the NiAs structure cannot be given at the present, however, but must remain as a task for future experimental investigation. — Author's abstract

02439 **Wang, Fun-Den; Panek, Louis A.; Sun, Meng-Cherng.** Stability analysis of underground openings using a Coulomb-Navier share [sic] failure criterion [abs.]: Mining Eng., v. 22, no. 1, p. 45, 1970.

02697 **Wanless, Harold R.** Influence of preexisting bedrock topography on bars of "lime" mud and sand, Biscayne Bay, Florida [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 875, 1970.

02917 **Ward, Stanley H.** Airborne electromagnetic methods [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 81-108, illus., 1970.

Many different airborne electromagnetic systems for operation from both fixed-wing aircraft and from helicopters have been developed in the last twenty years. The physical basis of all such systems is described in detail. Eighteen systems are classified on the basis of coil configuration and method of operation. A listing of factors in the design of AEM systems is amplified by a detailed discussion of system noise, geologic noise, and the separation of message from noise. The presentation of interpretational schemes and short catalogues of type curves for frequency-domain and time-domain systems facilitate a rigorous discussion of the relative merits of many AEM systems according to seven criteria. Anticipated future developments include: (1) multicomponent, multifrequency, and multiphase systems, (2) digital data acquisition, (3) automatic interpretation via computer, extension of the frequency range, and finally the inductive measurement of induced electrical polarization. — Author's abstract

Watkins, Joel S. *See* Eaton, Gordon P. 02999

02539 **Wayne, William J.** Slope evolution in southeastern Nebraska [abs.]: Nebraska Acad. Sci. Proc., 80th Ann. Mtg., p. 38-39, 1970.

02343 **Weems, John H.** George Irwin McFerron (1895-1969): Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1309, 1970.

03013 **Weidner, Donald; Madariaga, Raul.** Discussion of paper by M. Kumazawa, "The elastic constant of polycrystalline rocks and nonelastic behavior inherent to them" [1969]: Jour. Geophys. Research, v. 75, no. 14, p. 2787-2789, 1970.

The paper under discussion (ibid., v. 74, no. 22, p. 5311-5320, 1969), was cited in *Abstracts of North American Geology* for March 1970. — DBV

02698 **Welte, Dietrich H.** Petroleum exploration and organic geochemistry [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 875, 1970.

Wenninger, Guenther. *See* McCammon, Richard B. 02381

02879 **Werner, Christian.** Horton's law of stream numbers for topologically random channel networks [with French abs., p. 89]: Canadian Geographer, v. 14, no. 1, p. 57-66, illus., 1970.

According to Horton's law of stream numbers, the bifurcation ratio in a drainage network is fairly constant with an average value between 3.5 and 4, so that the stream numbers tend to form a geometric progression. This paper investigates drainage networks whose structure is controlled by chance only. The mathematical analysis shows that the expected stream numbers also approach a geometric progression, and that the corresponding bifurcation ratios approximate the value 3.618. — Author's abstract

02742 **Wertz, Jacques B.** The start of an ephemeral stream [with German and French abs.]: Zeitschr. Geomorphologie, new ser., v. 14, no. 1, p. 96-102, illus., 1970.

Deep ravines seem to form very suddenly in parts of the California desert. Distribution of the conspicuous desert varnish and changes in vegetation on flat, undissected portions of the peripediment give clues to the origin of a new valley. In the area extending from the western foothills of the Dome Rock Mts., Ariz., is a pediment fringe typical of the Basin and Range Province. This may suddenly be dissected into parallel gullies, 40 to 70 feet deep in places, by innumerable washes through the consolidated boulder pavement, lengthening as long as the cutting stream remains straight. Rapidity of development of the phenomenon is evidenced by a number of draws and trenches dug into and across old trails. All channels in this area show the consequence of insequent courses, deeply furrowed, but with no apparent reflection of underlying structure. — GDC

02958 **West, G. F.; Martin, L.; Grant, F. S.** Geophysical applications of modern computer systems [with French abs.], *in* Mining and groundwater geophysics, 1967: Canada Geol. Survey Econ. Geology Rept. 26, p. 191-201, illus., 1970.

Present applications of computers to mining and ground-water geophysics are mainly numerical evaluation for theoretical anomalies produced by idealized geological structures, plotting devices for graphs and contour plans, and computing theoretical anomalies directly, particularly for resistivity and IP. Time-series analysis and least-squares optimum filtering methods, widely used in seismic prospecting, have not found great application except in processing of aeromagnetic data. Digital data acquisition systems are being operated in conjunction with small computers by oceanographers and marine geophysicists to produce maps of reduced data during and after completion of surveys, techniques that may be practical in airborne geophysics. Basic data can also be filed to permit reprocessing by a different prescription if initial choice proves less than optimum. — *from* Authors' abstract

02281 **Whelan, J. A.** (compiler). Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), 75 p., illus., tables, 1970.

This compilation represents age determinations made at the University of Utah and by other laboratories to supplement various other geologic investigations in the state. Eleven lead-alpha, 17 K-Ar, and 2 Rb-Sr ages on minerals and whole-rocks are reported. Results suggest absence of Cretaceous intrusive activity, association of beryllium-uranium-fluorite mineralization with intrusive and extrusive rocks of granitic composition 25 m.y. ago or less, and broad correlation between Cu-Pb-Zn mineralization and intrusives slightly more basic than granite at 20 to 50 m.y. Oldest Precambrian rock in Utah is the Raft River Granite, 2.4 b.y. The Precambrian of the central Wasatch Mts. is 1.6 b.y., but exhibits a 550 m.y. thermal event. A thermal event may have affected the Precambrian of Antelope Island 224 m.y. ago. Analytical data are appended. Eleven papers on various areas are cited separately. — MCM

Whelan, J. A. *See* Sayyah, Taha. 02282

02285 **Whelan, J. A.** Mineral Range granite, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 25, 1970.

The largest granite pluton in Utah, 20 mi long and 6 mi wide, is exposed in the Mineral Range; sedimentary rocks (Precambrian through Cretaceous) have been intruded by this pluton. Nearby extrusive rocks include Tertiary volcanics and

Pleistocene and Recent basalts. An anomalous Pb-α age of 242 m.y. for zircon may be a relic age of the thermal event that imposed a deceptively young apparent age on the Precambrian rocks of Antelope Island. A K-Ar age of 15.5 ± 1.5 m.y. was obtained for biotite-muscovite associated with beryllium mineralization. A Pb-α age on zircon from granite of 10 ± 10 m.y. may have an error due to the low lead content of the zircon. — MCM

02288 **Whelan, J. A.** Notch Peak, House Range, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 35, 1970.

Notch Peak contains a stock of porphyritic quartz monzonite and associated sills that intrude Middle and Upper Cambrian limestone and shale. Some diopside monzonite occurs at contacts of the stock, and hornblende granite occupies the centers of some sills. A Pb-α age of 193 m.y. was obtained for zircon from the quartz monzonite; this Triassic age probably is anomalous, but it cannot be disproved by field relationships. — MCM

02290 **Whelan, J. A.** Rocky Range quartz monzonite, *in* Radioactive and isotopic age determinations of Utah rocks: Utah Geol. and Mineralog. Survey Bull. 81 (Utah Univ. Bull., v. 61, no. 18; Utah Eng. Expt. Sta. Bull. 135), p. 37, 1970.

Quartz monzonite occurs in the Rocky Range where it intrudes Paleozoic limestone and quartzite. Analysis of zircon from a sample of the quartz monzonite gave a Pb-α age of 97 m.y. A Tertiary rather than a Cretaceous age was expected for this stock; geologic relationships neither varify nor disprove this age. — MCM

Whelan, J. A. *See* Hashad, A. H. 02367

Whelan, J. A. *See* El-Shatoury, H. M. 02746

03002 **White, Donald E.; Miller, Lee D.** Geothermal infrared anomalies of low intensity, Yellowstone National Park, *in* Earth resources aircraft program status review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 16-1 — 16-4 [1970].

In searching for commercial geothermal reservoirs, significant evidence would be temperature gradients and heat flows 3 to 10 times higher than worldwide averages of 1°C/50m in depth for "normal" gradients and 1.5μ cal/cm^2 sec for conductive heat flow. Heat-flow maps were produced by using vertical photos and thermal IR 8μ to 14μ conventional scanner imagery at Old Faithful test site, Wyoming, and radiation temperature and soil heat-flow maps and IR imagery at Black Sand test site. Heat-flow contours of 1000 and 450μ cal/cm^{2}sec were mapped at Old Faithful and measurements between 5500 and 300μ cal/cm^2 at Black Sand test site. IR can detect obvious geothermal anomalies, and, by computer processing, can detect inconspicuous anomalies not visible by ground inspection. Low-intensity anomalies can be roughly calibrated in terms of heat flow at rates that range down to about 400μ cal/cm^{2}sec. — EH

Whitman, Robert V. *See* Schiffman, Robert L. 02353

02377 **Wiebe, Robert A.** Pre-Cenozoic tectonic history of the Salinian block, western California: Geol. Soc. America Bull., v. 81, no. 6, p. 1837-1842, illus., 1970.

The Salinian block is the elongate segment of the California Coast Ranges that lies between the Sur-Nacimiento and San Andreas fault zones. Known basement rocks within this block consist of Cretaceous and older granitic and high-grade metamorphic rocks that contrast sharply with Franciscan Group rocks east of the San Andreas and west of the Sur-Nacimiento fault zones. Mineral lineation and mesoscopic folds in Paleozoic(?) metamorphic rocks of the Salinian block indicate that major folding about northeast-trending axes occurred prior to prominent folding about north-northwest-trending axes. Assuming approximately 300 mi of post-Cretaceous right slip along the San Andreas fault, these metamorphic rocks are ten-

tatively correlated with similar Paleozoic and, perhaps in part, Precambrian rocks of the Mojave Desert and southwestern Tehachapi Mountains. — *from* Author's abstract

Williams, Frank E. *See* Tweto, Ogden. 02416

02331 **Williams, John R.** Ground water in the permafrost regions of Alaska: U.S. Geol. Survey Prof. Paper 696, 83 p., illus., tables, 1970.

Subfreezing temperatures in permafrost regions in Alaska result in profound modification of ground-water flow systems; restricted circulation may increase concentration of dissolved solids locally. In the continuous-permafrost zone, most economically developed sources are in unfrozen alluvium beneath large lakes and rivers; in the discontinuous zone, ground water is produced locally from shallow aquifers above permafrost of offshore bars and spits because water within or below frozen beach deposits is saline; elsewhere, potential contamination of shallow aquifers makes desirable a source of water beneath the frozen layer. Ground water is obtained from unfrozen bedrock above or beneath permafrost in mountains and uplands and locally in some valleys. Effects of permafrost on ground-water supplies of some population centers are summarized. — *from* Author's abstract

02260 **Williams, K. L.; Kullerud, G.** The Ni-Sb-S system: Carnegie Inst. Washington Year Book 68, 1968-69, p. 270-273, illus., 1970.

02337 **Williams, Roy E.** Groundwater flow systems and accumulation of evaporite minerals: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1290-1295, illus., 1970.

Mathematical analysis indicates that reported variations in ground-water quality are a function of flow-path length, flow-path route, and flow velocity. Evidence indicates that sites of accumulation of nonmarine evaporites are discharge zones of poor quality water. Under some conditions ground-water systems contribute dissolved solids to marine evaporite deposits. — WCC

Wilson, Augustus O. *See* Smith, Donald L. 02684

02699 **Wilson, James Lee.** Facies in organic buildups in epeiric seas and along shelf margins [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 875, 1970.

Winters, Harold A. *See* Folsom, Michael M. 02749

Wogman, N. A. *See* Rancitelli, L. A. 02272

Wogman, N. A. *See* Young, J. A. 02507

Wolf, Clarence J. *See* Levy, Ram L. 02737

Wolf, Frederick A. *See* Nease, Felton R. 02274

02275 **Wolf, Frederick A.; Nease, Felton R.** Nonpetrified fossils from the site of a phosphate mine in eastern North Carolina: Elisha Mitchell Sci. Soc. Jour., v. 86, no. 1, p. 44-48, illus., table, 1970.

Sediment from the site of a phosphate mine in eastern North Carolina contains nonpetrified fossil wood, leaves, pollen, mosses, algae, fungi, and the remains of certain animals. The kinds of organisms now living in the region are specifically like the fossils present in this sediment. Many genera and species of diatoms are present in the sediment. The most noteworthy fossil fungus recorded is *Cordana pauciseptata* present on leaves of a member of the Urticaceae. A long-buried fern leaf had remained green. — Authors' abstract

02996 **Wolfe, Edward W.** Geologic evaluation of thermal infrared imagery, Caliente and Temblor Ranges, southern California, *in* Earth resources aircraft program status

review, NASA, Houston, 1968 — V. 1, Geology, geography, and sensor studies: Houston, Tex., Manned Spacecraft Center, p. 12-1 — 12-27, illus., table [1970].

Thermal infrared (8-13μ) imagery was obtained in the Caliente and Temblor Ranges and Carrizo Plain, southern California, on June 18, 1965. Field observations, measurements of moisture and specific gravity of the regolith and radiation temperatures, and comparison with geologic maps and aerial photographs indicate: specific gravities of surficial materials influence tonal densities in predawn infrared imagery; geologic interpretation of tonal density patterns is complicated by topographic, atmospheric, and vegetative effects on predawn radiation; sensitivity of imagery to microclimatic anomalies may aid in recognizing some geologic features with subtle topographic expression; local radiative anomalies, thought to be caused by shallow ground water, may be caused by nighttime entrapment of cold air in poorly drained,, low areas; and postsunrise imagery, dominated by warming of slopes by early morning sun, resembles low-angle photographs. — *from* Author's abstract

02516 **Wolfe, W. J.; Wright, G. R.; McIlwaine, W. H.; Wallace, H.** (and others). Operation Maple Mountain — Biogeochemical distribution of cobalt in second year aspen and birch twigs, Whitson and Van Nostrand Townships, District of Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 600, scale 1 in. to 1/2 mi., text, 1970.

The map sheet contains a geologic map and a summary of the geology of Whitson and Van Nostrand Townships, and two maps showing Co × 100 and Co × 1,000/Zn concentrations, respectively. Sample sites were at intervals of 500-1,000 feet along hillside slopes in areas underlain by diabase. Based on analysis of 209 samples of second year growth poplar and birch twigs, Co concentration (oven-dried state) varied from 0.08 to 3.20 ppm. General patterns of Co and Co × 1,000/Zn are closely conformable. It seems possible that a combination of factors including high primary cobalt contrast, relatively high cobalt mobility in lower tills, and ability of poplar and birch species to concentrate dispersed cobalt may have produced anomalies that reflect the pattern of cobalt dispersion in the lower till. Anomalies may be significantly displaced from the primary source in a down-ice direction. — MCM

02734 **Wolfe, W. J.; Wright, G. R.; McIlwaine, W. H.; Wallace, H.** (and others). Operation Maple Mountain — Biogeochemical distribution of cobalt in second year aspen twigs, Charters and Donovan Townships, District of Timiskaming: Ontario Dept. Mines Prelim. Geol. Map P. 599, scale 1 in. to 1/2 mi., text, 1970.

The map sheet contains a geologic map and a brief summary of the geology of Charters and Donovan Townships, and two maps indicating concentrations of Co × 1,000/Zn and Co × 100, respectively. Sample sites were at intervals of 500-1,000 feet along hillside slopes in areas underlain by diabase. Biogeochemical information is based on analysis of 282 samples of second year growth aspen twigs; results are expressed in terms of metal concentration in the oven-dried state. General features of the Co and Co × 1,000/Zn patterns are reasonably consistent; range of Co is 0.05-1.60 ppm. It seems possible that high primary cobalt contrast, relatively high cobalt mobility in tills, and ability of poplar species to concentrate dispersed cobalt may combine to produce large biogeochemical patterns that reflect the pattern of cobalt distribution in the lower till. Anomalies may be significantly displaced from the primary source in a down-ice direction. — MCM

02875 **Woollard, G. P.** Evaluation of the isostatic mechanism and role of mineralogic transformations from seismic and gravity data, *in* Phase transformations and the Earth's interior — Symposium, Canberra, Australia, 1969, Proc.: Physics Earth and Planetary Interiors, v. 3, p. 484-498, illus., tables, 1970.

A review of seismic and gravitational evidence for mineralogic transformations in crust and upper mantle which could play an active role in isostatic mechanisms indicates that the orderly intimate interdependence of physical parameters between crust and mantle conforms to that expected for isostatic equilibrium at the M-discontinuity. This overall interdependence is present even where there is a sub-M-discontinuity, in which case isostasy is related to the column above the sub-M-discontinuity. Evidence of reversals in pattern defined by changes in crustal and upper mantle

parameters and associated with crustal uplift and subsidence suggests a reversible process. Abnormalities in heat flow also correlate with those in crustal and mantle parameters; temperature alone is unlikely to change the layered structure of the crust but could affect velocity values and the derived crustal thickness. The only alternative appears to be temperature control of mineralogic transformation involving change in density and rigidity. — VSN

02866 **Woolson, E. A.; Axley, J. H.; Kearney, P. C.** Soil calcium determination using a calcium-specific ion electrode: Soil Sci., v. 109, no. 5, p. 279-281, illus., table, 1970.

Sodium acetate was used to extract exchangeable calcium for 12 U.S. soils. Calcium was determined using a calcium specific electrode. The extract was diluted tenfold to eliminate most of the sodium interference. A standard of 0.05N $NaC_2H_3O_2$ was used to correct the remaining sodium interference. Results agreed favorably with atomic absorption spectrophotometric analyses: — JWH

Wright, G. R. *See* Wolfe, W. J. 02516

Wright, G. R. *See* Wolfe, W. J. 02734

02399 **Wright, Lauren A.; Troxel, Bennie W.** Summary of regional evidence for right-lateral displacement in the western Great Basin — Discussion [of paper by J. H. Stewart; J. P. Albers; F. G. Poole, 1968]: Geol. Soc. America Bull., v. 81, no. 7, p. 2167-2173, illus., 1970.

Wright and Troxel suggest that the mechanism of differential extension may offer a partial resolution of divergent interpretations of right-lateral displacement in the western Great Basin, particularly in the Black Mts. area of the Death Valley region. Stewart, Albers and Poole, 1968, support the "large displacement" concept, whereas Wright and Troxel, 1967, support the "small-displacement" concept. — VSN

02389 **Wright, Thomas L.; Doherty, Patrick C.** A linear programming and least squares computer method for solving petrologic mixing problems: Geol. Soc. America Bull., v. 81, no. 7, p. 1995-2007, tables, 1970.

Problems of petrologic mixing have been solved using a two-stage computer-based calculation. First, linear programming is used to obtain an approximate solution and to identify nonnegative solution values. Then a conventional least squares calculation is performed using the analyses represented by nonnegative solution values as input to yield an optimum set of solution values. The error attached to each solution value is estimated by an empirical procedure. Petrologic application of the program has been demonstrated with three types of calculations: chemical mode, magma mixing, and liquid line of descent. — *from* Author's abstract

02273 **Wrigley, Robert C.** Cosmogenic radionuclides in the Lost City, Oklahoma, meteorite [abs.]: EOS, v. 51, no. 7, p. 582, 1970.

Wyllie, P. J. *See* Lambert, I. B. 02872

Yamasaki, Kazuo. *See* Iida, Chuzo. 02961

Yanggen, Douglas A. *See* Parker, Dale E. 02384

02398 **Yeats, Robert S.** Stratigraphic evidence for Catalina Schist basement north of Channel Islands, California: Geol. Soc. America Bull., v. 81, no. 7, p. 2147-2151, illus., tables, 1970.

Sedimentological studies of the Miocene San Onofre Breccia, which contains blueschist clasts of Catalina Schist facies in abundance, suggest that Catalina-type basement rocks may underlie part of the Santa Barbara Basin north of the Channel Islands. The San Onofre Breccia exposed on Santa Cruz Island was derived from the northeast; this conclusion is based on paleocurrent indicators and a northeastward increase in blueschist clast size. On Santa Rosa Island, San Onofre Breccia is

restricted to the northern tip and the sea floor north of the island; rocks of the same age to the south are of a finer grained, deeper water facies. The size and angularity of San Onofre clasts suggest that the southern margin of the Catalina basement block was near the Santa Cruz Island fault. — Author's abstract

Yoder, H. S., Jr. *See* Kushiro, I. 02251

Yoder, H. S., Jr. *See* Schairer, J. F. 02256

02261 **Yoder, H. S., Jr.** Phlogopite-H_2O-CO_2 — An example of the multicomponent gas problem: Carnegie Inst. Washington Year Book 68, 1968-69, p. 236-240, illus., 1970.

Young, A. *See* Harris, D. G. 02626

02507 **Young, J. A.; Thomas, C. W.; Wogman, N. A.** Cosmogenic radionuclide production rates in argon in the stratosphere: Nature, v. 227, no. 5254, p. 160-161, tables, 1970.

For the past three years, air filter samples have been collected by aircraft and ground level air pumps, primarily for the purpose of measuring the atmospheric concentrations of cosmic-ray spallation radionuclides for studying atmospheric precipitation scavenging mechanisms. The production cross sections for these radionuclides by high-energy spallation have been determined as a function of energy by bombarding argon with protons of different energy in a cyclotron. Tables compare the semi-empirical cross sections of F-18, Na-24, Mg-28, Cl-34m, S-38, Cl-38, and Cl-39 from the proton spallation of argon, normalized to one for Na-24, with similar relative ratios determined experimentally at 18.3 km. The average energy of the spallating components producing the cosmogenic radionuclides in the argon spheres near 18 km appears to be about 280 MeV. — DBV

Zahner, Robert. *See* Hannah, Peter R. 02544

02755 **Zakrzewska, Barbara.** Paleo-geographic implications of clay ball deposits under Valderan till in eastern Wisconsin: Wisconsin Acad. Sci., Arts and Letters Trans. 1970, v. 58, p. 153-162, illus., table, 1970.

Numerous distinct layers of red clay ball deposits were found in stratified sands and silts under 7 to 10 feet of Valderan till just north of Two Rivers, Wis. The deposits probably represent a beach ridge of glacial Lake Calumet II which was present in this area just prior to the maximum advance of Valderan ice. This assumption is based on the fact that the highly spherical clay balls found in the deposit are similar to those found on nearby modern beaches and because of the position of the balls in the ridge which trends north-south roughly parallel to the shores of Lake Michigan basin. — EH

Zanazzi, P. F. *See* Fanfani, L. 02990

Zarrella, W. M. *See* Jeffrey, D. A. 02635

Zeitlen, J. G. *See* Komornik, A. 02457

02279 **Zetler, Bernard D.; Adams, William Mansfield.** International tsunami symposium: EOS, v. 51, no. 5, p. 479-480 and 511, 1970.

At the International Symposium on Tsunamis and Tsunami Research, held in Honolulu, Hawaii, October 7-10, 1969, seven countries were represented. Seminars were held on seismic source and energy transfer, tsunami instrumentation, and tsunami propagation of runup. The subjects of the various papers presented are reviewed. — DBV

Zlatkis, A. *See* Levy, Ram L. 02737

02786 **Zuidema, Henry P.** Fossil sea mammal: Sea Frontiers, v. 16, no. 1, p. 20-24, illus., 1970.

The first nearly complete remains of *Paleoparadoxia* to be found in North America is being reconstructed in a California laboratory, in presumed swimming and terrestrial postures. All except about 25 of its 200 bones were found in a Miocene shoreline now about 15 miles inland at Palo Alto, during excavations at Stanford University; the hind legs were fractured, probably by hitting rocks in the surf during a fall or jump from a cliff. Previously found cylindrical teeth and other isolated fragments justified the name; a Japanese skeleton of similar kind was considered a *Desmostylus*, a hoofed land animal. The Palo Alto specimen's broad and paddlelike feet and flexible digits are much more like living sea lions, although it is related to sirenians, the present-day sea-cow. It is considered that all desmostylians were adapted to swimming and were clumsy on land; presumably most of them were plant eaters. — GDC

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Solubility constant for $ZnSiO_3$, invalid: Norvell, W. A. 02552

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